The role of nurse-led telephone triage in supporting older adults with multimorbidity to engage in digital self-management

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Declaration

We, the undersigned declare that this thesis entitled ‘The role of nurse-led telephone triage in supporting older adults with multimorbidity to engage in digital self-management’ is entirely the author’s own work and has not been taken from the work of others, except as cited and acknowledged within the text.

The thesis has been prepared according to the regulations of Dundalk Institute of Technology and has not been submitted in whole or in part for an award in this or any other institution.

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Research Outputs

Journal papers:

Doyle, J., **McAleer, P**., van Leeuwen, C., Smith, S., Murphy, E., Sillevis Smitt, M., Galvin, M., Tompkins, L., Sheerin, J. and Dinsmore, J. (2022). The role of phone-based triage nurses in supporting older adults with multimorbidity to digitally self-manage – findings from the ProACT proof-of-concept study. *Digital Health* [online], 8. Available from: https://doi.org/10.1177/20552076221131140 [accessed 01 September 2024].

Doyle, J., Murphy, E., Gavin, S., Pascale, A., Deparis, S., Tommasi, P., Smith, S., Hannigan, C., Sillevis Smitt, M., van Leeuwen, C., Lastra, J., Galvin, M., **McAleer, P.**, Tompkins, L., Jacobs, A., Marques, M.M., Medina Maestro, J., Boyle, G. and Dinsmore, J. (2021). A digital platform to support self-management of multiple chronic conditions (ProACT): findings in relation to engagement during a one-year proof-of-concept trial. *Journal of Medical Internet Research* [online], 23(12). Available from: https://doi.org/10.2196/22672 [accessed 31 August 2024].

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Additional research output:

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Ding, J., Yu, Y., Kong J., Chen, Q. and **McAleer P.** (2023). Psychometric evaluation of the Student Nurse Stressor-14 Scale for undergraduate nursing interns. *BMC Nursing*, 468. Available from: https://doi.org/10.1186/s12912-023-01631-z.

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List of Abbreviations

CDSS	Clinical decision support software
CeCC	Call Enhance Call Centre
CF	Cystic fibrosis
CHD	Chronic heart disease
CHF	Chronic heart failure
COPD	Chronic obstructive pulmonary disease
CVD	Cardiovascular disease
DHI	Digital health intervention
DHT	Digital health technology
ED	Emergency department
HCP	Health care professional
HSE	Health Service Executive
HTN	Hypertension
M-health	Mobile health
ProACT	Integrated Technology Systems for ProACTive Patient Centred Care
PwMs	People with multimorbidity
RCT	Randomised control trial
Resp.	Respiratory conditions
SEURO	Scaling EUROpean citizen driven transferable and transformative digital health
SMILE	Supporting Multimorbidity self-care through Integration, Learning and e-Health
T2D	Type 2 diabetes
TTN	Telephone triage nurse

UN	United Nations
WHO	World Health Organisation

The role of nurse-led telephone triage in supporting older adults with multimorbidity to engage in digital self-management

Patricia McAleer

Abstract

In the European Union (EU), an estimated 50 million individuals live with multimorbidity — defined as the co-occurrence of two or more chronic conditions — a prevalence that increases with age and imposes significant and growing pressure on health care systems. As populations age, health care services must evolve to meet the complex, long-term needs of older adults living with multiple conditions. Effective strategies to support older adults in self-managing their conditions are essential, and digital health technologies (DHTs) are increasingly recognised as a promising means to achieve this. DHTs can enable people to monitor their symptoms, adhere to treatments, and engage more actively in managing their own well-being. However, while these technologies offer significant potential by making health care more accessible, proactive and personalised, many older people with multimorbidity (PwMs) face barriers to sustained engagement such as low digital literacy, heightened anxiety around illness or technology use, and limited confidence in interpreting health data. In this context, human support, particularly through nurse-led telephone triage services, is emerging as a complementary approach to enhance engagement with DHTs. Through a multiphase mixed methods study, this thesis aims to examine the role of Telephone Triage Nurses (TTNs) in supporting PwMs to engage in regular and sustained self-management of their health and well-being from home using DHTs.

Study 1 employed a qualitative design to explore the experience of stakeholders involved in the SMILE project. Ten older PwMs, who had been using the ProACT digital health platform to self-manage their conditions for approximately eight to 10 months, participated in semi-structured interviews to share their experiences of using the platform and interacting with the TTNs. Additionally, a focus group was held with three TTNs who provided remote clinical monitoring and support, and one-on-one interviews were conducted with a general practitioner (GP) and a practice nurse (PN).

Study 2 expanded on these insights through a two-part mixed methods investigation, nested within the SEURO project. Part 1 involved the analysis of objective engagement data from 64 older PwMs who had used the ProACT platform for a 6-month period, allowing for a comparison between those who had access to TTN support (n=32) and those who did not (n=32). Part 2 complemented this analysis, by analysing engagement data and conducting semi-structured interviews with a sub-sample of 24 PwMs from the same cohort, providing qualitative insight into engagement patterns, motivations, and perceived value of the TTN service. This mixed methods approach enabled a comprehensive understanding of both the measurable outcomes of engagement and the personal, contextual factors that shaped it.

Findings from Study 1 indicated that the perception of being monitored encouraged participants to remain engaged in their self-management routines, with TTNs providing reassurance and a sense of safety. TTNs in turn highlighted the value of having longitudinal health and well-being data to inform more timely and accurate assessments and more targeted clinical responses. Despite the remote nature of the service, both PwMs and TTNs described their interactions as supportive and relational, with emotional support emerging as a key feature of the service. Study 2 further reinforced the importance of human support, with quantitative data demonstrating higher levels of engagement among those with TTN support compared to those without such support. Qualitative insights elaborated that TTN involvement helped PwMs make sense of data, provided reassurance, increased motivation and helped address health concerns, thereby contributing to more sustained use of the platform.

These findings have important implications for the integration of DHTs in health care delivery for older PwMs. While DHTs alone can provide tools for tracking and managing chronic conditions, their success depends on being embedded in supportive care pathways. TTN support not only facilitates sustained engagement with DHTs but also enhances self-management capacity and reduces health care burden. To harness this potential, further research is needed to optimise models of DHT integration with remote clinical support, with particular attention to how such support can be scaled and tailored to meet the diverse needs of older PwMs.

Keywords: Digital health technology, engagement, multimorbidity, older adults,
self-management, Telephone Triage Nurse.

Chapter 1: Introduction

1.0 Background

Over the past 50 years, global life expectancy has been increasing exponentially, showing little sign of slowing down (Jagger 2015). For instance, between 2000 and 2016 global average life expectancy increased by 5.50 years to 72 years (74.20 years for females and 69.80 years for males), which represents the fastest increase since the 1960s (World Health Organisation [WHO] 2019a). Further, worldwide the number of older adults (aged 65 years+) has grown significantly in recent years, with growth forecast to accelerate even faster in the coming decades (United Nations [UN] 2015). The number of people aged 80 years+ (the 'oldest-old') is increasing faster than the number of older adults overall. It is estimated that by 2050 the oldest-old will number 434 million, tripling the 2015 figure of 125 million (*ibid*.). Although one of the greatest achievements of the modern age is this increase in life expectancy, people are living longer but not necessarily living *well* for longer (Jagger 2015) which is confirmed by the fact that global healthy life expectancy in 2016 was estimated to be just 63.3 years (WHO 2019a).

The prevalence of chronic health conditions such as cancer, cardiovascular disease (CVD), chronic obstructive pulmonary disease (COPD) and dementia is increasing as a result of an ageing population, and it is asserted that this may become the norm rather than the exception (Feather 2018). In high-income countries, it is estimated that more than 25% of the adult population live with chronic health conditions which rises to 50% in the population aged over 65 years (*ibid*.). In Ireland for example, whilst research into the issue is scant, available figures reveal that 66% of the population aged over 50 years has two or more chronic conditions (Hernández et al. 2019; Glynn et al. 2011). However, multimorbidity is not restricted to older age groups and is growing in prevalence among younger people (Stairmand et al. 2018). A substantial proportion of middle-aged people (45-65 years old) are being diagnosed with multimorbidity with a higher number in this age group diagnosed with it than in older age groups (Barnett et al. 2012). Moreover, Morse (2014) reports that those aged between 50 and 64 years are the largest group reporting with multimorbidity.

1.1 Defining multimorbidity

There is no consensus on the correct terminology for the presence of multiple health conditions (Johnston et al. 2019; Nicholson et al. 2019; Almirall and Fortin 2013). Nicholson et al. (2019) point out that this lack of consensus makes it difficult to conceptualise the burden of living with multiple health issues, while Johnston et al. (2019) are more explicit, asserting that conducting research and interpreting the findings are made challenging, which results in difficulties in developing guidelines and interventions. Further, the true extent of multiple chronic disease is difficult to assess because of the lack of one definition for it (The Academy of Medical Sciences 2018). Two terms – 'comorbidity' and 'multimorbidity' – are frequently used interchangeably to describe the occurrence of two or more chronic (slow-developing, long-term and often un-curable) illnesses which require complex care and management (Nicholson et al. 2019; Xu et al. 2017; Almirall and Fortin 2013). However, there is a difference in meaning. Comorbidity was coined in 1970 by Alvin R. Feinstein to refer to the presence of additional diseases beyond an index condition, characterising it as "any distinct additional clinical entity that has existed or that may occur during the clinical course of a patient who has the index disease under study" (Feinstein 1970). According to Marengoni et al. (2011), this definition implies that the focus of interest lies in the index condition and the possible effects of other illnesses on its prognosis. However, a myriad of other definitions of comorbidity exists in the literature including: “more than one chronic disease” (Schellevis et al. 1993, p.469); “the association of two distinct diseases in the same individual at a rate higher than expected by chance” (Bonavita and De Simone 2008, p.99); “three or more clinical conditions” (Cesari et al. 2006, p.24); “the presence of more than one clinical condition” (Saltman et al. 2005, p.474); “the co-existence of multiple chronic conditions in a single individual (McGee et al. 1996, p.381); and, “the concurrence of multiple health conditions in the same person” (Droomers and Westert 2004, p311.), for example. This ambiguity in the use of terms was highlighted by van den Akker et al. in 1996 who subsequently recommended that the term multimorbidity should be used in situations where there is no index disease present. Almirall and Fortin (2013) termed an index disease as being the principal illness that takes precedence over its co-existing illnesses. In this research study for purposes of clarity, the term multimorbidity is used throughout to refer to people presenting with two or more chronic conditions.

1.2 The cost of multimorbidity to health services

Chronic health conditions now supersede infectious diseases as the main focus of health care as they are the principal causes of morbidity and mortality in many countries and are proving to be a major cause of concern for health services that traditionally focus on acute care (Palmer et al. 2018). In fact, they are the leading cause of premature mortality worldwide, accounting for around 70% of deaths (WHO 2019a). For instance, in the EU 85% of all deaths – four million annually – are caused by chronic diseases (Brennan et al. 2017). Further, the cost of care places a considerable financial burden on EU health services, with

€700 billion or 70% to 80% of the total spend on health care being spent on chronic illnesses annually (*ibid.*).

According to Bähler et al. (2015), multimorbidity is associated with twice as many contacts with health care professionals (HCPs) and those contacts increase in number with each additional illness. Further, their research with older adults found that hospitalisations were not only more likely for people with multimorbidity (PwMs) than for people without multimorbidity, but also that their length of stay in hospital was twice as long. Navickas et al.'s (2016) research corroborates this, contending that in Europe, PwMs are not only high users of health care resources but are also some of the costliest and most difficult to treat patients, with the cost of care increasing with each additional condition (Xu et al. 2017). Vetrano et al. (2018) caution that while multimorbidity is one of the strongest predictors of health care utilisation, many health systems lack the capacity to coherently address the health needs of PwMs and also, the care given is frequently not based on scientific knowledge. The chapter now continues with a brief discussion of the impact that multimorbidity has on people who live with it – physically and mentally, and also the impact on their quality of life.

1.3 The impact of multimorbidity

Multimorbidity places a significant burden on people who live with it, physically, mentally, socially and financially. PwMs are at risk of functional decline and disability, in addition to having to take multiple medications (polypharmacy) and requiring frequent health care utilisation which leads to poor quality of life (Xu et al. 2017; Jokanovic et al. 2015). Health care may be disjointed as PwMs are required to make multiple, often badly coordinated visits to several health care providers. Additionally, the problem of seeing different clinicians at repeat visits to the same clinic is cited frequently as the main reason for non-attendance at appointments (Feather 2018). Moreover, various conditions require different and occasionally incompatible treatments which affect long-term recovery (Slattery et al. 2017). Multimorbidity is also linked to a decline in physical and mental functioning and is associated with an increased risk of mortality (Kandola et al. 2020; Read et al. 2017; Nunes et al. 2016; Marengoni et al 2011; Boyd and Fortin 2010).

Much has been written about the profound effect of multimorbidity on the physical health of those who live with it (Kandola et al. 2020; Bao et al. 2019; Chang et al. 2019; Steeves et al. 2019; Stairmand et al. 2018; Keats et al., 2017; Vancampfort et al. 2017; Dhalwani et al. 2016; Nunes et al. 2016; Bock et al. 2014; Cimarras-Otal et al. 2014). Decreased physical health results in increased sedentary behaviour concomitant with decreased levels of physical activity elevated risk of mortality which increases with the number of conditions, a greater risk of disability, and poor health outcomes such as pain and sleeping problems, for example. Sedentary behaviour is classified in the literature as more than eight hours per day spent sitting or reclining (not including hours spent sleeping) which is associated with a higher risk for premature mortality (Ekelund et al. 2016). Further, sedentary behaviour is linked to multiple inflammatory processes that can contribute to the development of multimorbidity in older adults (Duggal et al. 2019; Nilsson et al. 2018).

Another major impact of multimorbidity is the effect that it has on the mental health of people living with it, due to the psychological burden it places on them (Stairmand et al 2018). Wong et al. (2019) found a prevalence rate of 66.70% for depression among respondents aged 65+ years with three or more conditions. It was unclear however from the findings whether the prevalence rate increased with the presence of a higher number of illnesses. Notably, they determined that while this population had high levels of depression or anxiety, they were less likely to report the condition than the younger participants in their study (those aged 18 to 64 years old), which they argued, indicated that older adults are more likely to develop resilience and also the ability to live better with multimorbidity.

Depression's impact on health is most acute when it co-exists with chronic physical conditions (Moussavi et al. 2007). The impacts of comorbid depression and multimorbidity for PwMs include difficulties such as greater diminution in standard of health, increased length of hospitalisations and readmissions, and higher rates of mortality compared to people who experience either depression or physical illness (Coventry et al. 2015; Ayerbe et al. 2013; Barnett et al. 2012; Chang et al. 2010; Fiske et al. 2009). Further, PwMs who experience comorbid depression may be less inclined to adhere to medical or behavioural regimens (Mezuk and Gallo 2013).

The final negative impact of multimorbidity is that on the quality of life and health-related quality of life of PwMs, which has been extensively researched in recent years (Bao et al. 2019; Herzig et al. 2019; Makovski et al. 2019; Pati et al. 2019; Sum et al. 2019; Wong et al. 2019; Park et al. 2018; Stairmand et al. 2018; Rosbach and Andersen 2017; Bock et al. 2014). Moreover, Marengoni et al. (2011) characterised poor quality of life as being one of the key consequences of multimorbidity. Quality of life is also an important measure in appraising health care services and patient-reported outcomes (WHO 2012), who have defined it as:

> *…an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. It is a broad ranging concept affected in a complex way by the person's physical health, psychological state, personal beliefs, social relationships and their relationship to salient features of their environment* (WHO 2012)

Makovski et al. (2019) undertook a systematic review and the first meta-analysis on this issue, of 78 and 39 papers respectively, to understand the relationship between multimorbidity and quality of life and to explore the strength of this association. Their results demonstrated that health-related quality of life deteriorated with each additional chronic condition, with physical health being impacted more than mental health. Further, similar to Herzig et al. (2019), the researchers found a strong correlation between age of the PwM and perceived burden of treatment, with younger patients demonstrating lower levels of health-related quality of life. Brettschneider et al. (2013) analysed the impact of 45 chronic conditions on quality of life in PwMs, without preselecting particular diseases. Their findings supported those of Makovski et al. (2019), with a greater number of conditions resulting in lower levels of health-related quality of life, and further, they found that the severity of conditions also decreased quality of life. The conditions that had the highest impact were Parkinson's disease, depression and obesity.

In summary, the above literature highlights the wide-ranging impacts of multimorbidity on those who live with it. Every aspect of a PwM's life is impacted, not only physically and mentally but quality of life is also deeply affected. Self-management is complex, as it requires frequent visits to a variety of HCPs and numerous hospitalisations. PwMs need to actively engage with the self-management of their conditions, and this will be discussed below.

1.4 Patient engagement in their own health care

A patient's engagement with their own health care self-management is characterised by Barello and Graffigna (2015) as being a process in which a fully engaged patient emerges from a series of emotional, cognitive, and behavioural adjustments of their health, and that their success in completing this process depends on how they fared in previous phases of the process. The authors have defined patient engagement as being:

> *A dynamic and evolutionary process featuring four experiential positions (blackout, arousal, adhesion, and eudaimonic project) that involves peculiar ways of interaction, roles and power dynamics between the patient and the doctor that strongly depends on the phase of the process through which the patient is passing*
> (Barello and Graffigna 2015)

According to Dentzer (2013), patient engagement in self-management is considered to be the keystone of a health care revolution in which health outcomes are improved and care costs are reduced. Indeed, the author argues that it should have been at the heart of health care all along, given that patients who actively participate in their own health care achieve better health outcomes and cost health systems less. Légaré and Witteman (2013) suggest that the time spent with their HCP as they receive diagnoses, learn about health issues and decide how best to improve their health is the best time for patients to become engaged in their own health through shared health decision making.

The concept of patient engagement is broadly recognised as improving health outcomes and enhancing care, and as health care transitions from being disease-centred to patient-centred, it will play a fundamental part in future health care delivery (Higgins et al. 2017). Indeed, engagement has been characterised as an underused resource in health by the US National Coordinator (ONC) of Health Information Technology (2013), which cites health IT strategy consultant Leonard Kish's statement that ′if patient engagement were a drug, it would be the blockbuster drug of the century and malpractice not to use it', to underscore their assertion. Further, Zuckerman et al. (2013) suggest that patient engagement is central to creating patients who are co-producers of their own health and well-being which leads to improved health outcomes and lower health care costs.

1.4.1 Patient engagement with digital health technology

DHT is shaping the future of health care delivery, driven by the shift towards a knowledge-based economy. The emergence of DHT has arisen from an urgent need to address the growing burden of chronic diseases (Bhavnani et al. 2016), Moore's law – the increasingly rapid growth in computer power resulting in the development of smaller and cheaper electronics (Moore 1965), and finally, health care models becoming more patient focused (Topol 2010). DHT is used by people to monitor their health in order to understand how healthy they are. For instance, fitness trackers can help the user to keep track of their daily step count, which can be increased if the target is not met, thus helping the user to improve their health and well-being (Nicholas 2019).

This engagement with DHT can be viewed in terms of usability and usage and the factors that impact upon them (Yardley et al. 2016). For instance, O'Brien and Toms (2008) characterise it as being users' experiences with technology which includes aspects such as challenges; aesthetics and sensory appeal; novelty; interactivity; feedback; awareness; motivation; interest; and, affect. Yardley et al. (2016) suggest that engagement is a dynamic process, started by a recommendation from a HCP or peers, use of the DHT, and followed by sustained engagement, disengagement or change to another type of intervention. This process varies depending on the DHT, the user and their context.

However, engagement levels with technology-based health interventions are concerning, with limited participation and high attrition rates being common (Yeager and Benight 2018; Lie et al. 2017). For example, digital health applications are abandoned by more than 25% of people after only one use which implies that users are not gaining real health benefits from achieving their health goals (Todd 2016). Moreover, Yardley et al (2016) warn that dropout rates and 'non-usage attrition' are higher when there is no human support system in place for users. This factor is also mentioned by Lupton (2020) who asserts that the abandonment of wearables for instance, results from a lack of community support as well as users not being provided with what they require. Issues such as users perceiving their health goals to be unattainable or irritating reminders and alarms also contribute to low engagement rates (*ibid*.). Other barriers to engagement are the time required to learn how to use applications and the steep learning curve that this requires, in addition to tedious data entry (Kelley 2014). Moreover, users frequently distrust applications, finding it difficult to know how accurate they are (Ketchum 2012).

These barriers are also encountered by older adults when engaging with DHT but they face additional difficulties related to the ageing process. For instance, visual and hearing difficulties can impact physical engagement with DHT (Wilson et al. 2021), while cognitive impairment can affect attention span and acquiring new information (Nymberg et al. 2019; Borg et al. 2015). Older adults also report problems with DHT such as a lack of experience with computers and other types of technology, and not having access to the internet (O'Reilly et al. 2022). Another important barrier to engagement with DHT for older adults is the lack of supports, both technical and social, i.e., support received from either HCPs, peers or family members (Wilson et al. 2021). van Middelaar et al. (2018) emphasise the need for human support when engaging older adults in the use of technology. However, HCP support is not always available, for reasons such as time constraints, HCPs feeling burdened by having to monitor patient data, and the conflict between what a patient expects from their HCP and what the HCP can provide (Doyle et al. 2022).

1.5 Nurse-led telephone triage services

Until the 1980s, telephone triage was performed solely by physicians, but came to be predominantly carried out by nurses (Wheeler et al. 2015). Subsequently, nurse-led telephone triage services have been introduced in many high-income countries and have proven to be cost-effective, safe and high quality (Mulcahy et al. 2017). The literature identifies triage as a procedure in which telephone calls from ill members of the public are received by trained staff who assess and manage the calls by either giving advice or referring them to a more appropriate service (*ibid*.). It is a way for people to avoid needless visits to an HCP and to save unnecessary expenditure on health care (Onubogu and Earp 2013; Andersson Bäck 2008). According to Vaona et al. (2017), telephone triage services have become an integral part of modern medicine with almost a quarter of all care consultations being conducted by telephone in the USA for example. One of the main reasons for implementing such a service is to lessen the burden of care on GPs and emergency departments (Lake et al. 2017). Indeed, Jácome et al. (2019) found that Telephone Triage Nurses (TTNs) were effective in directing adults aged 65+ years who presented with chronic conditions to a telephone triage service, to the appropriate type of care, thus reducing the overall demand for care. TTNs achieved this by either downgrading the patients' initial intentions to attend acute or emergency care, or upgrading them from the initial intention to stay at home. Further, the majority of the patients to the service (85.60%) intended to comply with the referral advice given by the TTNs.

Extant research into nurse-led triage services has primarily focused on examining issues such as cost effectiveness (de la Torre-Diéz et al. 2015); triage nurse decision making (Ekins and Morphet 2015); and, triage nurse training (Kaakinen et al. 2016) for example. As will be highlighted in Chapter 2, limited research to date has been conducted into the support that telephone triage can provide for PwMs' who are self-managing their conditions through the use of technology to engage in their self-management and this study proposes to fill that knowledge gap. Providing PwMs with support to better self-manage their health conditions may offer a solution to mitigate the considerable burden that living with multimorbidity imposes upon them.

1.5.1 The work of the TTN

Three phases in the triage process have been identified by Greenberg (2009) as gathering information (starting, seeking information and secondary gathering); cognitive processing (determining the problem, decision-making and planning) and finally, output (disposing, supporting, collaborating and finishing the call). Kaminsky et al. (2009) elaborate on these processes by pinpointing five categories of help given to patients: (1) assess, refer and give advice; (2) support them through a follow-up call to check on their well-being; (3) give encouragement; (4) educate them by listening and instructing; and (5) enable their learning. TTNs work systematically to organise and deliver health care through prioritising the type and complexity of the patient's symptoms, and deciding on the correct course of action (Onubogu and Earp 2013). The patients' information is assessed, and advice is given or an onward referral to the appropriate agency is made.

These decisions have to be made without the benefit of seeing patients face-to-face, and yet the TTN is expected to display the ability to make critical decisions that are accurate, safe and provide good health outcomes for patients (Kaakinen et al. 2016; Ekins and Morphet 2015; Onubogu and Earp 2013). However, these decisions are frequently made using systems or protocols that lack the patient's perspective which can provide TTNs with important non-verbal information on the severity of their symptoms (Gamst-Jensen et al. 2018).

A subsequent study also by Gamst-Jensen (2019) built on their 2018 research into the effect of patients' degree of worry on triage outcomes. Worry is a normal reaction to illness or injury and has been categorised as the emotion that leads to problem-solving behaviour (van Ierland et al. 2011). Gamst-Jensen et al.'s (2019) study was conducted in order to explore the effect of call-handlers' (nurses or doctors) awareness of degree of worry on their responses to patients, which were to recommend either a telephone or face-to-face consultation. The authors hypothesised that an awareness of degree of worry would lead to less face-to-face consultations. Participants were randomly allocated to either an intervention group (n=5,705) or a control group (n=5,708). The patients in the intervention group were asked to rate their degree of worry on a 5-point scale when they called the triage service. Their answers were then shown to the call-handlers on the computer system before they answered the call, which they could use at their discretion in deciding what response to give. The findings revealed that awareness of degree of worry did not affect call-handlers' responses, with no difference found between the intervention and the control groups in the number of face-to-face consultations. Further, call-handlers did not use the degree of worry information systematically and were in fact reluctant to use it, as they felt it placed too much responsibility on patients and would compromise their professional intuition.

1.6 The context for this study

ProACT (Integrated Technology Ecosystems for ProACTive Patient Centred Care) was a research programme that developed and evaluated a digital integrated health platform, ProACT, to support older adults living with multimorbidity to self-manage their chronic conditions (chronic heart disease (CHD), chronic heart failure (CHF), COPD and diabetes (Doyle et al. 2021). This PhD candidate worked on the study as a Research Assistant, contributing to the deployment of technologies in PwMs' homes, ongoing technical support, design of data collection protocols, collection of qualitative and quantitative data with participants in their homes, analysis of data and write-up. During this study, it became apparent that the 120 participants in Ireland and Belgium found the support from the TTNs who were employed by Caredoc in Ireland, an external company who provided the study with telephone triage services, and Z-Plus in Belgium, to be a significant help to them with the self-management of their multimorbidity (Doyle et al. 2022; Doyle et al. 2021). As there was little existing research into this subject, this was the topic chosen for the PhD research herein. Conducting research on this topic was made possible through two large-scale projects that involved older PwMs self-managing using the ProACT digital health platform with TTN support. The first is the Health Service Executive (HSE) Sláintecare Integration Fund project SMILE (Supporting Multimorbidity self-care through Integration, Learning and e-Health) that was coordinated by Caredoc. SMILE began in January 2020 and was conducted across three counties in the South-East of Ireland, with PwM participants referred to the trial by their respective GPs. The second project is SEURO (Scaling EUROpean citizen driven transferable and transformative digital health), a Horizon 2020 project involving a large-scale pragmatic randomised control trial of the ProACT platform, with one third of participants receiving TTN support also from Caredoc. Participants in this project came from a wide geographical spread across the East and South-East of Ireland. Without the resources these projects provided, including for example software developers implementing and maintaining the ProACT platform, a large team of researchers running the trials and the TTN staff providing triage, this PhD research would not have been possible.

1.7 Aim and objectives of this study

1.7.1 Aim:

This thesis aims to examine the role of TTNs in supporting people with multimorbidity to engage in regular and sustained self-management of their health and well-being from home using digital health technology.

1.7.2 Objectives:

The objectives are:

- Objective 1: To review and critique the literature in relation to PwM engagement in self-management, including digital self-management, and to understand the role played by TTNs in supporting self-management;
- Objective 2: To explore how PwMs self-manage their conditions using DHT with TTN support, their motivation to self-manage, and the barriers they face with self-management;
- Objective 3: To identify the tasks undertaken by TTNs supporting PwMs to self-manage using a DHT and to explore the nature of the PwM/TTN partnership;
- Objective 4: To examine whether a cohort of PwMs using a DHT with TTN support demonstrates different patterns of engagement with the DHT compared to a cohort without TTN support, and to explore the factors influencing these differences through qualitative data from both groups.

1.8 This study’s significance

This research contributes to a greater understanding of how PwMs using DHT for health self-management can be supported by TTNs to engage in the process. This is important for future health care service delivery, yet there is little extant literature related to this subject. Indeed, the type of telephone nurse monitoring described herein has not been identified in the literature to the best knowledge of this researcher, and hence, this is the first study to examine the phenomenon.

Irish government estimates indicate an increasing and rapidly ageing population with subsequent elevated health care needs (Sheehan and O’Sullivan 2020). Projections reveal that the number of people aged 65+ years in the Republic of Ireland is set to double to almost 1.60 million by 2051 (Central Statistics Office 2018). This reflects global trends in the rise in population of older adults. For example, the UK population of 65 years+ is projected to grow to 17.40 million by 2043, comprising 24% of the total population (UK Parliament 2021), of which 21,000 will be centenarians (Office for National Statistics 2022). Further, in the USA the same population is projected to total 77 million adults by 2034 (United States Census Bureau 2019), the first time that older adults will outnumber children – projected to total 76.50 million and finally, in Australia the number of adults aged over 65 years is expected to increase to between 6.40 and 6.70 million by 2042 (Australian Bureau of Statistics 2018). In addition, with ageing there occurs a higher incidence of chronic diseases (Doyle et al. 2022) but chronic disease is not restricted to older adults as research indicates that there is also an increase in its prevalence in younger populations, caused in part by lower socioeconomic status allied with other issues such as poor lifestyle choices, sex and ethnicity (The Academy of Medical Sciences 2018).

Moreover, it is well documented that health care systems in Ireland and also worldwide face major staff shortages. For instance, in Ireland, HCPs have faced a deterioration in working conditions due to issues such as their inability to take holidays because of a lack of replacement cover, retirement, and an increasing number of practitioners moving abroad to work for better pay and conditions (IHCA 2020; Hayes et al. 2019; Humphries et al. 2018). A medical workforce facing such difficulties clearly significantly impacts health care system development (Public Policy 2020).

With the burgeoning growth in the older adult population and the issues with HCP retention as described above, it is vital that health care planners prepare for an increasing health care demand and hence, appropriately plan and allocate resources. One solution may lie in digital health technology and restructuring the provision of services to support the roll-out of nurse-led triage. Thus, there is a critical need to conduct research into this issue, which is addressed in this study.

1.9 Thesis outline

This thesis comprises eight chapters. Commencing with this chapter which provides the background to this study, it proceeds with Chapter Two which contains the literature review that critiques the extant literature relating to the self-management of multimorbidity, how TTNs support self-management and PwMs' engagement with DHT. Chapter Two also presents the theoretical framework used in this study, which is The Conceptual Framework for Patient Centered Care (PCC) (Hudon et al. 2011). The dearth of literature relating to the role of TTNs in supporting PwMs self-managing their health using DHT to engage in their self-management represents a critical gap which the present study aims to address. Chapter Three describes the research methodology used in this study. The choice of multiphase mixed methods research design will be discussed, giving the rationale for this choice. Chapter Four discusses the research methods used herein. It begins with an overview of the ProACT platform, before outlining the two studies that were conducted as part of this PhD. For each study, an overview of participants and recruitment is provided, followed by an explanation of the study procedures and data collection instruments, and finally the data analysis methods. Chapter Five presents the qualitative findings from Study 1, which was conducted within the SMILE project, and which focused on the supports provided by TTNS to PwMs using the ProACT platform to self-manage their health and well-being. Chapters Six and Seven present the findings from Study 2, which was conducted within the larger SEURO project. Chapter 6 investigates the quantitative findings from the PwMs' objective engagement levels with the ProACT platform and self-management in two trial cohorts of which one had TTN support and the other which did not. Chapter Seven presents the mixed methods findings from a sub-set of 24 PwMs' objective engagement levels with the ProACT platform. In addition, the findings from interviews conducted with these participants are presented, with the qualitative data providing a context for the engagement data. Finally, Chapter Eight contains the discussion and implications of the study's findings, including limitations, research contributions and future research directions.

1.10 Chapter summary

This introductory chapter highlighted the myriad issues that PwMs encounter when living with multiple chronic illnesses. The cost to health systems of managing multimorbidity and the knock-on effect on health care delivery was discussed. The concept of patient engagement in health and well-being self-management, including engagement with DHT, was introduced, followed by an overview of nurse-led telephone triage and the role of TTNs. The context for the study was outlined, followed by its aims and objectives. The scope of the research in this thesis is based on exploring how PwMs may be supported to engage in their health self-management through having support from TTNs. Finally, the significance of the study was discussed. Chapter Two which follows provides a review of the current literature relating to PwMs' self-management, the role of the TTN in supporting them, and patient engagement with DHT.

Chapter 2: Literature Review

2.0 Introduction

Multimorbidity has been the focus of a significant amount of research in recent years, driven by the growing awareness that it is a major public health issue. The aim of this study as stated previously in Chapter One, is to explore the role that TTNs play in keeping PwMs engaged in the use of technology to self-manage their conditions. Therefore, the purpose of this chapter is to present a critical appraisal of the body of literature pertaining to this issue. A narrative literature review was conducted to achieve this purpose and was selected because it is an appropriate method for identifying, analysing, assessing and interpreting a body of knowledge (Coughlan and Cronin 2021). The literature reviewed herein is taken from primary research papers and systematic reviews. The gap in the literature regarding these issues is identified. The research question that this study addresses resulted from the literature review which is: '*would older PwMs engage in regular and sustained digital self-management of their health without the support of TTNs?'*

2.1 Literature identification process

Due to the paucity of Irish studies in the area of research which is addressed in this thesis, research from 13 countries across the globe including countries such as the UK, USA, Australia, Sweden, Norway, Denmark and Portugal was included. Literature was sourced from databases such as Academic Search Complete, CINAHL, ProQuest, Science Direct and Scopus. Other sources used were Google Scholar, Mendeley, ResearchGate and grey literature. Hand searches of the reference lists of articles identified in the database searches were also conducted to maximise the number of potential papers for inclusion in this review. Trial searches of each database were undertaken which involved creating combinations of the key terms and search strings, using guidelines from Flinders University (2020). This was to ensure that the results yielded the most relevant literature. The final key terms and search string combination is found in Table 1 below.

Table 1: *Final key terms and search string combination for literature sourcing*

Search Strings
Multimorbid* *or* comorbid* *or* “multiple chronic cond*” *or* “multiple chronic dis*” *or* “multiple health cond*”
and
“Digital health” *or* “digital health interven*” *or* “digital health tech*” *or* “mobile health” *or* “mobile health tech*” *or* “remote health” *or* “remote health monitor*” *or* telecare *or* telehealth *or* telemedicine
and
“Self care” *or* self-care *or* “self management” *or* self-management
and
“Telephone triage nurs*” *or* “telephone triage” *or* “telephone helpline nurs*” *or* telenurs*
and
“Patient engagement” *or* “patient activation” *or* “patient involvement” *or* “shared decision making”

2.1.1 Selection of relevant literature

To manage the potentially large number of papers retrieved from searches, a methodical selection process was undertaken which involved firstly reading the title and abstract to ascertain whether the paper was relevant to this study. Secondly, articles deemed relevant at this stage were subjected to a detailed reading of abstracts combined with in-depth reading of the full texts. The outcome of this phase of the selection process determined the final decision to include or exclude papers.

The final search string retrieved a total of 290 papers. Title and abstract reading led to the exclusion of 128 studies, resulting in 162 papers being subjected to in-depth abstract and full text reading. Following the exclusion of 64 duplicate papers, 98 papers were initially deemed to be of interest to the present study. Ultimately, another 22 papers were excluded, leaving 76 articles remaining in the literature review (Figure 1 below).

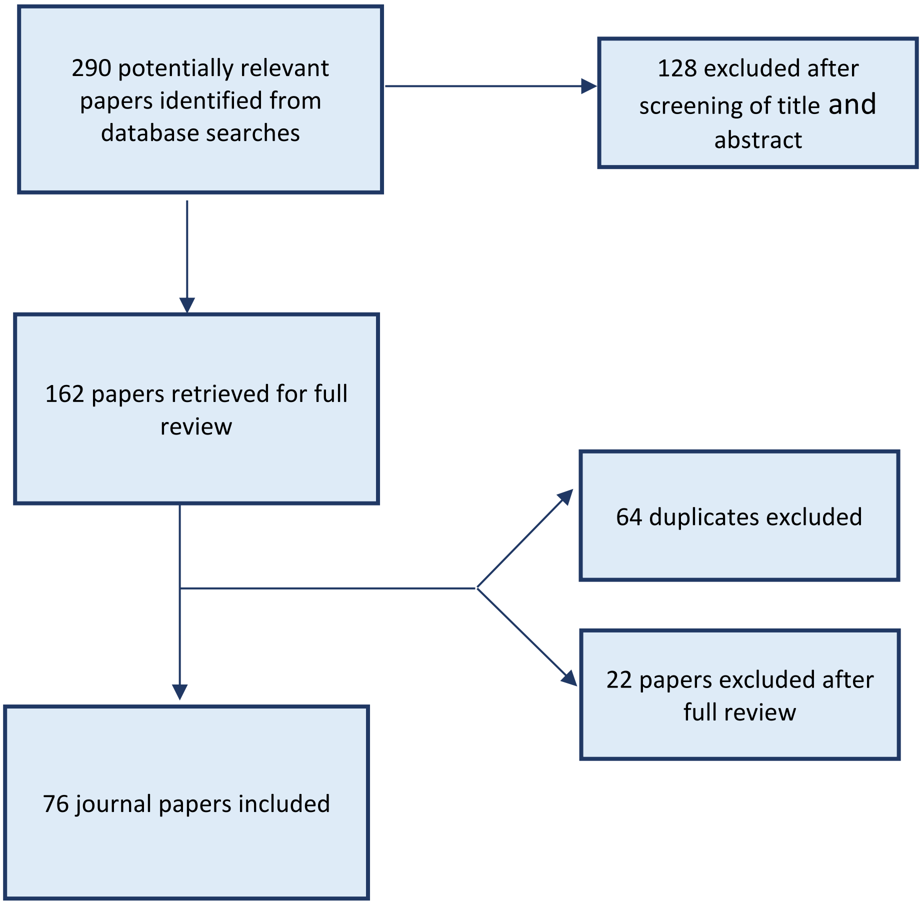


Figure 1: Flowchart of database searches

2.2 Inclusion and exclusion criteria

The literature reviewed in this study spans a period of 13 years from 2008 to 2020 with the majority of the studies focused on the past five years, which assists in maximising the relevance of this thesis' findings (Paniagua 2002). Indeed, Coughlan and Cronin (2021) recommend that the majority of studies included in a literature review are as contemporary as possible, with exceptions being made for seminal works, or if the topic under review has a small number of recent studies available for inclusion. This time frame was selected because digital health is a rapidly evolving field and it was important to capture contemporary developments in technology, clinical practice, and user engagement, while also retaining earlier studies that established foundational concepts or frameworks. Further, setting a clear date range ensured consistency and manageability during the review process and avoided the inclusion of outdated studies with technologies no longer in use. In addition, papers included in this review had to be written in English. The type of research included in the review were systematic reviews, and cross-sectional, longitudinal and Delphi-studies.

2.3 Themes

Three overarching themes were developed during the literature review which include the self-management of health conditions, the role of the TTN in supporting PwMs, and the concept of patient engagement (Figure 2 below).

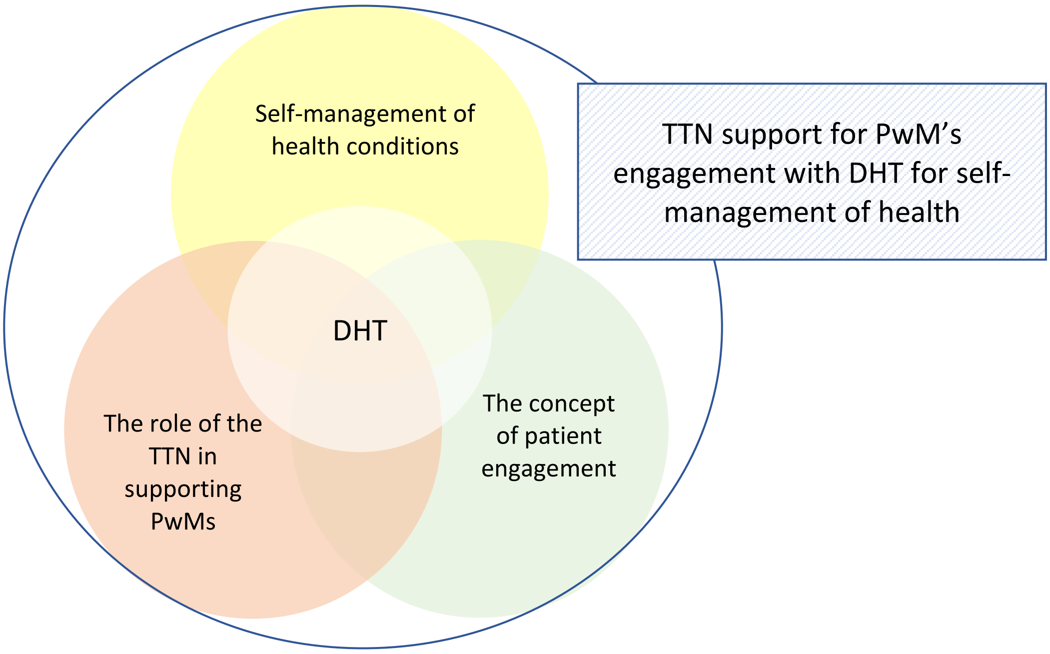


Figure 2: Three key themes of this research

This chapter is organised into four sections. The first section examines how PwMs self-manage their health, including using technology to self-manage. Section two looks at the role of the TTN in supporting PwMs in that self-management and continues with identifying the challenges they face in providing support to patients. Section three investigates the issues surrounding engagement in the self-management of health. Finally, the fourth section discusses the theoretical framework used in this study to examine the phenomenon under investigation. The majority of the research relating to the issues considered in this thesis has been conducted worldwide. From a cross-cultural perspective, it is therefore important to examine these topics from an Irish perspective. They are discussed in turn below.

2.4 Self-management of health conditions

There is a general consensus in the literature that self-management is an integral part of improving PwMs' health outcomes (Bartlett et al. 2020; Gobeil-Lavoie et al. 2019; Scholz Mellum et al. 2019; Garnett et al. 2018; Ko et al. 2018; Rosbach and Andersen 2017; Dwarswaard et al. 2016; Meranius and Hammar 2016; Bratzke et al. 2015; Mofizul Islam et al. 2015; Park and Chang 2014; Maneze et al. 2012). In order to achieve better health outcomes, it is essential that PwMs are successful in the self-management of their conditions which necessitates them to set priorities and make decisions on a daily basis (Bratzke et al. 2015). It is described in the literature as being an 'iterative process' that requires patients to learn effective techniques to manage their illness, and cope over time through trial and error (Miller et al. 2015). This process is viewed as a component of living with chronic conditions within the range of personal, social, spiritual contexts and daily life specific to each person (*ibid*.).

Self-management is a term commonly used in health education and is ascribed to behavioural interventions and health behaviours (Lorig and Holman 2003). It is frequently associated with the work of Corbin and Strauss (1988) who undertook research into the management of chronic illness at home. They identified three aspects of chronic disease management which are: medical advice, behaviour/role management and emotional management. Another definition of self-management comes from Miller et al. (2015) who argued that self-management is the engagement in behaviours that ensure treatment and medication adherence in addition to managing symptoms or exacerbations. Further, PwMs must continuously monitor their health and well-being, and take appropriate action when their symptoms worsen (*ibid*.).

Lorig and Holman (2003) asserted that only the patient can take responsibility for their own care and contended that for most people, self-management is a lifetime undertaking. In addition, they argued that a person cannot *not* manage their own health; even if they decide not to engage in healthy behaviours or actively manage an illness, this is still a management style. This management style was termed ‘strategic non-compliance’ by Campbell et al. (2003), who observed that this was an important approach in coping with diabetes and striking a balance between the illness and the patient’s quality of life. They characterised strategic non-compliance as being the thoughtful and selective uptake of medical advice rather than blind adherence to it. This literature review continues with an exploration of the literature relating to the different aspects of self-management such as health care decision making, the factors that enable self-management, the role of the TTNs in supporting self-management and self-management of health through the use of digital health interventions (DHIs).

2.4.1 Decision making and priority setting

Two papers were identified that examined the processes of decision making and priority setting in the self-management of multimorbidity. According to Bratzke et al. (2015), decision making and priority setting are iterative processes that must co-exist in the self-management of multimorbidity. They conducted a systematic review of 13 papers which described the processes and facilitators/barriers of self-management, to understand PwMs' decision making and priority setting. The findings revealed that PwMs prioritised a dominant condition and re-prioritised as conditions and treatments changed. The authors found that the identification of a dominant illness may be influenced by its severity, symptoms and both short and long-term consequences. Decision making was based on PwMs' beliefs about their illnesses and treatments such as, when not in agreement with their HCP about priorities and management goals, they were less likely to follow the recommended advice given to them. Facilitators/barriers to self-management included multimorbidity itself, the cognitive, emotional and physical capacity for self-management, their financial situation, and the quality of communication with HCPs. Further, a lack of knowledge about illnesses and treatments, receiving contradictory treatment advice, the number of medications prescribed and the complexity of their health routines were identified as additional barriers.

Gobeil-Lavoie et al. (2019) undertook a systematic review of 21 papers in order to identify the characteristics of self-management in PwMs. A need to prioritise self-care based on the identification of one dominant health condition was important. However, prioritisation of care was made difficult as PwMs were found to be at greater risk for depression, lack of motivation and low self-efficacy. Further, between 25% and 80% of the participants in these studies, received contradictory health advice which further complicated self-management.

2.4.2 The factors that enable self-management

A concept analysis of 30 articles was conducted by Garnett et al. (2018) with the aim of identifying the factors that PwMs needed to successfully self-manage. The authors found that using financial resources, PwMs educating themselves on health and disease related topics, using social supports, dealing positively with changes in health, ongoing engagement in health care and finally, taking part in continuing disease management increased the likelihood of successful self-management. However, this was not the case in populations where there was a lack of sufficient financial resources, poor physical environments, inadequate social support networks and no access to a health care team.

Scholz Mellum et al. (2019) qualitatively explored the methods used by 30 PwMs aged 65+ years to manage their care, identifying two types of actions they took to do this; firstly, by living within their limits and secondly, by ‘living with grit’. Living within their limits was characterised as PwMs taking actions to continue on as usual or to flourish in spite of being restricted due to symptoms such as shortness of breath, functional difficulties and pain. The actions they took included implementing doctor’s orders, comparing themselves to others, using assistive equipment, limiting activities, resignation and relying on support from family. Living with grit was classified as PwMs being determined to be in charge of their illness management as much as possible and using strategies to achieve this. These strategies included having a positive mental attitude, staying active, maintaining mental agility, proactive health and well-being management, reassessing their insurance and believing in a higher power. Although there were two distinct approaches to self-management, all PwMs wanted to remain in control of their own health and actively engage in life.

2.4.3 Supports

Another aspect of self-management is the supports that PwMs require to do so, effectively. These supports may come from HCPs, family, friends or fellow patients. The next section of this review discusses the various supports required by PwMs to successfully self-manage.

Bartlett et al. (2020) explored how PwMs self-manage in order to identify the supports that matched their needs. This cluster analysis of data extracted from an online survey of 247 PwMs aged 18+ years identified three types of self-manager: (1) vulnerable self-managers (n=55) with the highest task frequency and lowest self-efficacy; (2) confident self-managers (n=73) with the lowest task frequency and highest self-efficacy; and (3) moderate needs self-managers (n=119) with both intermediate task frequency and self-efficacy. The PwMs classified as vulnerable participated less often in self-help groups than those in the confident group and preferred different types of support such as assistance with improving their communication and shared decision making with HCPs as well as requiring help with monitoring their illnesses. Individual counselling sessions was identified as the method of choice for providing the PwMs across all three groups with education and help with making lifestyle changes.

Dwarswaard et al. (2016) in a thematic synthesis of 37 qualitative studies found that people with chronic conditions did not self-manage in isolation. Rather, they needed instrumental, psychosocial and relational supports such as assistance with medical management, strengthening of emotional and psychological resources, and positive interactions with other people from HCPs, family, friends and fellow patients. Regarding instrumental support, patients expected HCPs to do more than provide information. They wished to be involved in discussions about new self-management strategies and to also get emotional support from their HCPs. Emotional support from fellow patients was valuable in enabling self-management as knowing others experienced the same symptoms helped them feel less anxious. This review also revealed that relational supports were the most important type and that the other supports were driven by them. The importance of relational supports to self-management is borne out in previous studies which highlighted that a PwM's ability to self-manage is influenced by their social networks (Brown 2013; Vassilev et al. 2013; Schermer 2009). However, Dwarswaard et al. (2016) also discovered that support from relatives is not always positive and in fact, could add to the PwMs' burden, as they felt dependent on them or felt compelled to have a positive attitude towards their illness.

A small mixed methods study conducted by Maneze et al. (2012) examined the role of multidisciplinary care in providing support for patients (n=13) with comorbid diabetes. The lack of self-management support from HCPs was perceived by participants as contributing to challenges for them in being actively involved in their own care. They felt that there was a lack of support in terms of health education, follow-up care and goal setting for their diabetes management which resulted in a demotivation to self-manage.

Meranius and Hammar (2016) undertook qualitative research with 20 Swedish PwMs aged 65+ years into how the health system affected their ability to self-manage their medications. The participants perceived that effective medication self-management was established through good communication with their HCP who took time to explain the medications' effects and possible side-effects to them. When this was absent, PwMs found it difficult to follow their prescription regimens, became fearful and caused them to stop taking their medications or modify the dosage where appropriate. The authors concluded that while Swedish health systems were able to treat a PwM's symptoms, they were unable to provide the support necessary to help them to achieve and promote good health.

The effectiveness of a health coaching programme for PwMs in a nursing home was explored by Park and Chang (2014). This approach was instigated to support the PwMs to achieve their health goals. The four goals that were selected as being appropriate for self-management were oral health, stress reduction, PA and healthy diet. In total, 43 PwMs participated in the study, and were randomly selected to either an intervention group (n=22) or a non-intervention group (n=21). The intervention group participated in group health education and exercise sessions, and individual counselling for the goal-setting element of the programme, whereas the conventional group only participated in group health education and exercise sessions. The results revealed that self-management behaviours, self-efficacy and health status were all significantly improved in the intervention group compared to the non-intervention group. Additionally, the PwMs reported high levels of goal attainment, particularly in relation to stress reduction and improved oral health but did not attain their goals to increase their PA or improve their diet. In this section of the literature review, the theme of PwMs' self-management of their health conditions has been explored. It is evident that PwMs do not self-manage in isolation but instead, require various forms of support to do so – instrumental, psychosocial and relational. This thesis now continues with an exploration of self-management using DHT.

2.4.4 Digital self-management

Digital health care is a fast-growing part of health care, with its significance being identified by the WHO which published its first global strategy for digital health in 2019 (Calthorpe et al. 2020). This report investigated existing DHIs and made recommendations for future development for the sector (WHO 2019b). Digital health has been characterised by Bhavnani et al. (2016) as the coming together of technology with health, health care and society to deliver an efficient health care system. It entails using information and communication technologies (ICT) to assist ill people with their health-related problems and challenges (*ibid*.). Technologies used include email, electronic heath records, clinical decision support software (CDSS), mobile health (m-health) systems (e.g., smartphones, mobile phone apps and tablets), telemedicine (the delivery of medical advice using technology to patients at a distance), wearable devices and monitoring sensors, which play an important role in helping people to make better-informed decisions about their health (The American Telemedicine Association 2020; Calthorpe et al. 2020; US Food and Drug Administration 2020; Fadahunsi et al. 2019; Widmer et al. 2015).

Traditionally, the doctor-patient relationship has been unequal, as it has been the doctor alone who has had direct access to their patients' medical information (Singh et al. 2016). However, that relationship is changing, as the growing proliferation of DHT permits patients to track their health and increase their knowledge about their health, without needing a doctor's help (Nicholas 2019). The growth in digital health care has been fuelled by the development of powerful and portable computing devices, allied with the wider availability of reliable broadband speeds (Singh et al. 2016). This growth is answering the need to address the growing burden of chronic disease (*ibid*.) and the shift in a health care model from one that was health systems led to one that is becoming increasingly patient-led (Topol et al. 2015). According to Singh et al. (2016), these issues provide an opportunity to increase patient engagement with their health and well-being, improve health outcomes and also, to reduce the cost of health care. Indeed, the authors argue that patients are increasingly becoming consumers which enables them to engage in informed decision making with their HCPs.

2.4.4.1 The barriers and facilitators to digital self-management

While DHT offers a way of improving health outcomes, nonetheless barriers such as difficulty of use, time constraints, fear of technology and its impersonal nature can create obstacles to its adoption by patients (O'Connor et al. 2016; Gorst et al. 2014; Sanders et al. 2012). Barriers to the use of DHT for self-management of health will now be discussed in greater depth below. Please note that the majority of studies included in this section are limited to single-disease focused due to the lack of studies relating to multimorbidity.

Villalobos et al. (2020) examined the barriers, limitations and benefits of using DHT to self-manage type 2 diabetes (T2D). This scoping review included 25 studies which focused on the communication between T2D patients and their HCPs, and the behavioural changes brought about by the use of DHT which included mobile phones, apps, Bluetooth devices and web sites. The barriers identified by the authors included a lack of face-to-face contact between patients and HCPs, poor health which resulted in patients not understanding their disease or its treatment, and finally, the usability of the technology, which included issues such as ease of use, technical problems and being seen as burdensome to use on top of other self-management routines.

A T2D systematic review conducted by Pal et al. (2013) revealed that computer-based DHTs which included internet-based and mobile phone-based interventions were limited in their effectiveness in improving health outcomes and quality of life. The 16 randomised control trials (RCTs) included in this review indicated that only small improvements in blood glucose control were found and that the impact was larger in the sub-group who used mobile phone-based interventions to self-manage. Pal et al. (2013) concluded that this was possibly due to mobile phone-based interventions being more convenient and intensive (multiple daily contacts) and hence, patients being more likely to adhere to the advice given. They also hypothesised that the type of interventions used in m-health which were more likely to use prompts and cues to encourage healthy behaviours and give swift feedback afterwards would result in a higher impact on blood glucose levels. In conclusion, the authors found that none of the DHTs aided weight loss, coping with depression or improved health-related quality of life.

A systematic review which found limited effectiveness in the use of DHT for self-management of health was undertaken by Calthorpe et al. (2020). They found that the use of digital technology for home monitoring, adherence and self-management by people diagnosed with cystic fibrosis (CF) was not always effective. In fact, their review of the literature revealed there was limited evidence to support its use by CF patients, although it was unclear as to the evidence for this. Further, the authors cautioned that developers need to develop technology which is sustainable, suitable, and does not add to the considerable treatment burden of people with health conditions such as CF. While Calthorpe et al.'s (2020) finding was interesting, nevertheless it must be noted that this review, while comprehensive – encompassing 59 articles and protocols from 48 studies over a 20-year time period from 1999 to 2019 – included only three randomised control trials and one systematic review. The authors themselves acknowledged that the quality of the literature reviewed was low and that the majority of studies were small pilot and intervention studies without comparators.

In addition to the barriers that were discussed above, a number of facilitators of digital self-management have also been identified in the literature (Wilson et al. 2021; Park et al. 2020; Nymberg et al. 2019; Cajita et al. 2018). Wilson et al. (2021) undertook a scoping review of 14 papers to investigate how and why older adults engaged with e-health and the facilitators of that engagement. They found that the facilitators mapped onto five thematic factors: individual (desire to learn, motivation to make lifestyle changes); technological (ease of use, free or low-cost equipment); relational (training and support to learn how to use technology); environmental (availability to users in remote locations); and, organisational (recommendations from HCPs, content designed by experts).

Cajita et al. (2018) assessed the perceptions of older adults with CHF regarding the use of m-health and identified potential facilitators of its adoption. The m-health used by the 10 participants in this study was an app that tracked dietary salt intake which is important to people with CHF. The app was chosen for this study because it was free to download. Cajita et al.'s (2018) findings revealed that older adults do not base their use of m-health only on its perceived ease of use and usefulness. Instead, other facilitators discussed by participants included previous experience with m-health, a willingness to learn how to use it, training to learn how to use it, free equipment and recommendations from HCPs.

In another study that examined the use of m-health, Park et al. (2020) examined the perceptions, attitudes and beliefs of 28 older adults with CHD about using apps and text message reminders for medication adherence. Park et al. (2020) found that the participants perceived text message reminders as a convenient and easy tool that facilitated them to establish a routine for taking medications, particularly when starting to use a new medication. In addition, text message reminders helped the participants to know when to take their medication as well as how much to take. The participants who tested two medication adherence apps for a total of one week each, were keen to learn how to use them as they found they had greater interactivity than text message reminders, provided them with individualised health monitoring, and personalised information about their medications.

A study conducted by Nymberg et al. (2019) explored 15 older adults' beliefs, attitudes, experiences and expectations of e-health services in Sweden, using focus groups as the method of data collection. The participants in this study had at least one chronic illness –

COPD, hypertension (HTN) or T2D and had experiences of using e-health such as online HCP appointments, looking for medical information online and using apps for self-monitoring. Nymberg et al. (2019) found that despite the participants' ambivalence towards e-health because of previous experiences of using it, mistrust in new technology, and a lack of knowledge of DHT for example, nevertheless the participants expressed a willingness to learn about it and to use it, although the authors noted that this was with some reluctance.

2.4.4.2 The benefits of digital self-management

DHT has grown in usage because it provides benefits over traditional health services such as convenience, 24-hour accessibility once there is access to the internet, cost savings, time savings and the ability to be personalised to a user's specific needs (Murray et al. 2016). Digital health care can promote healthy behaviours such as smoking cessation, weight loss, physical activity and reduced alcohol consumption (*ibid*.). It can also improve health outcomes in people with long-term conditions such as diabetes, heart disease and mental conditions (McLean et al. 2016; Hollis et al. 2015; Pal et al. 2013). Other benefits to the user include being able to share similar experiences to others in the same situation, manage medication, change health behaviours and better communication with their HCP (Murray et al. 2016).

A systematic review conducted by Widmer et al. (2015) assessed the potential benefit of DHT for cardiovascular outcomes such as heart attack, stroke, hospitalisations and death, and also its risk factors such as weight, BMI, blood pressure and cholesterol, compared to non-DHT care approaches. 51 articles which included any type of DHT – telemedicine, m-health, sensors, email and web-based strategies – were included in the review. The review found that DHTs were effective in improving outcomes such as heart attacks, stroke, hospitalisations and death when compared to the usual care given to patients. A reduction of almost 40% in these outcomes was noted. Moreover, weight loss, reductions in BMI, and improvements in blood pressure and cholesterol were observed. In reviewing the types of DHT that were most effective, Widmer et al. (2015) found that web-based interventions, telemedicine and texts had particular benefits, but that there were insufficient data to prove if email-based DHT was beneficial.

Similar to Widmer et al. (2015), a systematic review and meta-analysis conducted by McLean et al. (2016) showed that of the seven RCT studies included in their review, in four (57%) there was a significant improvement in systolic blood pressure levels when DHT was used to self-manage blood pressure, in comparison to usual care. Further, of the six studies that reported findings for diastolic blood pressure, four (66%) indicated a greater improvement in blood pressure levels when compared to usual care. However, the strength of this study's findings is limited, firstly, because results were reported overall in terms of vote counting i.e., the number of studies that reported positive versus null results, and secondly, because of the small number of studies reviewed. Vote counting is problematical as it treats all studies equal regardless of their quality which can result in misleading conclusions.

In Villalobos et al.'s (2020) scoping review which reviewed the barriers and limitations of digital self-management in the previous section, the authors also found that mobile phones significantly improved self-management goals such as weight loss, medication adherence and physical activity rates. Websites were good for assisting patients to deal with a negative health behaviour such as lack of exercise, as they raised awareness of such negative behaviour and thus, helped them to change their habits. For HCPs, digital health systems were useful for tracking their patients' data and raising awareness with them whenever they needed to improve their health behaviours. Further, Villalobos et al.'s (2020) findings revealed that digital health is particularly useful in situations where T2D patients have a low income or live rurally. This thesis continues with the next theme which will look at the concept of patient engagement.

2.5 The concept of patient engagement

While patient engagement is now a common term in the health literature, according to Finset (2017) it is only since the 1990s that it and other related terms such as 'patient activation' and 'shared decision making' have appeared. Since then, there has been a proliferation of research concerning this issue (Yang et al. 2019; D'Agostino et al. 2017; Ibe et al. 2017; Sacks et al. 2017; Graffigna et al. 2014). Patient engagement was defined by Higgins et al. (2017) as being the wish and the ability to actively choose to participate appropriately in health care in a way that is unique to the patient. This is done in partnership with an HCP with the goal of maximising health outcomes or improving care experiences. It is both process and behaviour which are influenced by the relationship between the patient and their HCP in tandem with the environment where health care is delivered (*ibid*.).

The term patient engagement is used to define concepts that range from proactive health behaviours to the interventions used to improve those behaviours (Higgins et al. 2017; Barello et al. 2014). Further, Graffigna et al. (2014) proffer an explanation for it, asserting that it is a process and multidimensional experience that results from the cognitive, emotional and conative (the effort to do something [Cambridge Dictionary 2021]) actions of patients towards their own health care.

2.5.1 The attributes of patient engagement

In spite of the fact that patient engagement has become a widely used term in health care, nonetheless it remains a poorly understood concept (Higgins et al. 2017). Their study aimed to rectify this by undertaking a concept analysis of health literature using Rodgers' (2000) evolutionary concept analysis method to define the concept, by distinguishing its characteristics in the context of its use. This method uses six steps to accomplish this: (1) a concept of interest is identified; (2) a setting and sample for data collection is identified; (3) the relevant data is collected; (4) the data is analysed; (5) model cases are identified; and (6) implications, hypotheses and further development of the concept are identified. 96 articles were included in the analysis and 446 individual attributes were highlighted. Based on a process of thematic reflection during analysis of the data, Higgins et al. (2017) found four defining attributes of patient engagement: personalisation, access, commitment and therapeutic alliance, which are described briefly below.

Personalisation: describes the need to tailor interventions or health care strategies to the individual circumstances of the patient. This involves health literacy – the ability of the patient to obtain, process and understand basic health information – and the services required by them to make the right health care decisions. The patient's cultural background, their attitudes to health interventions and the availability of support systems must also be considered.

Access: this attribute refers to the patient's ability to obtain appropriate information or institutional resources while having confidence in their availability. It includes literacy status, geographic location or socioeconomic status.

Commitment: defines the cognitive and/or emotional factors that enable the patient to exploit available resources. These factors include elements which motivate them to understand their illness and take steps either alone or with others to achieve this.

Therapeutic alliance: is a factor that distinguishes patient engagement from other related terms such as patient empowerment, involvement or self-management. It supports the patient's connection to the HCP and potentially creates a partnership which is effective in achieving desired health goals.

However, there are weaknesses with the concept analysis. For example, the literature review was conducted only by the lead author which increased the possibility of subjectivity and bias occurring thereby reducing its rigour and trustworthiness. Further, the only articles used in the literature review were those that used the term 'patient engagement', which reduced the richness and complexity of the concept.

2.5.2 The impact of patient engagement on health

In their scoping review of T2D DHIs which was discussed previously, Villalobos et al. (2020) found that improving engagement with interventions such as food logging, weight loss goal setting and monitoring daily steps taken, resulted in increased weight loss in patients, an important health outcome for people with T2D. Engagement was improved by providing technical support to patients which resolved issues which could potentially have created a lack of interest in the interventions and hence, disengagement. A coaching programme using tailored motivational messages and reminders, the social support received from family members and finally, group peer support on social media platforms such as Facebook were also found to be important factors for retaining engagement.

A study conducted by Hibbard et al. (2017) assessed how engagement levels (expressed here as patient activation) impacted on cancer patients. The study analysed data from six surveys conducted with cancer patients in order to determine how activation levels were associated with the adoption of healthy behaviours such as exercise and a healthier diet, symptom management, communication with HCPs and health care satisfaction. Unsurprisingly, the authors found that more activated patients were more proactive in managing their health, were effective in their symptom and medication side effects management and were more likely to understand their diagnosis. Conversely, the disengaged patient is not only passive in regard to their own health, but also does not engage in health promoting behaviours (Hibbard and Cunningham 2008). This has the potential for declines in health, poor access to health care and a waste of health care resources (*ibid*.).

Disengagement was explored by Graffigna et al. (2014). This qualitative study explored the experiences of 29 uncontrolled type 2 diabetic patients in which they were required to keep a one-week diary which recorded their experiences of self-management and the reasons why they disengaged from it. Lack of knowledge of their condition, the emotional toll of dealing with their illness, difficulties in sticking to their medication routine and problems in communicating with HCPs were the four most frequently cited reasons for self-management disengagement.

Effective communication is crucial for patients not only in self-managing their health but also for keeping them engaged in their self-management (D'Agostino et al. 2017). The authors conducted a systematic review of 32 studies to investigate the role that communication training plays in promoting patient engagement in interactions with HCPs. Of the 32 studies included in this review, n=25 (78%), were either cancer or primary care focused, with the remaining seven studies having a focus on HIV (one), community (four), paediatric surgery (one) or gastroenterology (one). Findings suggested that training patients in communication skills did increase their active participation in health care interactions, but that there was little indication that this training improved their health, psychosocial well-being or treatment-related outcomes.

Communication's impact on patient engagement with HCP interactions is also examined by Ibe et al. (2017) in a RCT of 140 patients with HTN attending face-to-face coaching sessions aimed at engagement in visits to HCPs. The intensity of the intervention was measured by examining the duration of the coaching session, the number of intervention topics (e.g., medication adherence, diet, physical activity knowledge of HTN and stress) and the frequency of discussion of these topics. Results found that the length of the coaching session increased the number of communication engagement strategies used by patients in subsequent visits to their HCP. However, while these findings are positive, a note of caution must be urged, as this RCT did not include a control group of patients who did not receive the coaching intervention, so it was not possible to compare potential differences in communication.

Sacks et al. (2017) examined whether patient engagement (in this study defined as patient activation), could predict the course of T2D over a three-year period. This study comprised longitudinal analyses of the health records of 58,277 patients, of whom n=10,071 were diabetic, n=1,804 were pre-diabetic and n=46,402 were neither diabetic nor pre-diabetic. Outcomes measured were clinical indicators (blood pressure, cholesterol and triglycerides), care utilisation and the development of diabetes or pre-diabetes over the course of the three-year research period. The non-diabetic sample was included for this reason. The results revealed that diabetic and pre-diabetic patients who were more activated had better clinical outcomes and a lower likelihood of being hospitalised than those less activated, and finally, in the sample of non-diabetic patients, more activated patients were less likely to develop diabetes than less activated patients. One way that patients can engage effectively with their health and well-being management is through the use of DHT which is discussed below.

2.5.3 Engagement with digital technology for self-management

DHT plays an important role in the effective self-management of chronic diseases, having the potential to overcome some of the difficulties patients face in the health care system such as expensive health care which may be difficult to access and poorly synchronised (Chien et al. 2020; Villalobos et al. 2020; Fortuna et al. 2019; Ng et al. 2019; Escriva Boulley et al. 2018; Hibbard et al. 2017; O'Connor et al. 2016; Reti et al. 2010). Reasons for engaging with DHT instead of availing of face-to-face consultations with HCPs include: cheaper cost; ease of access; and, patients can easily keep and access their own records (Greene et al. 2013; Mitzner et al. 2013). Kelley (2014) also highlights other benefits such as user-friendliness, usefulness and motivational factors. However, the potential benefits of DHTs are often limited by lack of engagement (Milne-Ives et al. 2024). Yardley et al. (2016) argue that more engagement is simply not enough and that 'effective engagement' should be promoted instead. They define effective engagement as: "sufficient engagement with the intervention to achieve intended outcomes".

A study by Chien et al. (2020) explored through machine learning techniques the patterns of engagement of 54,604 adults with depression and anxiety with an internet based cognitive behavioural therapy DHI. Five classes of engagement were observed, ranging from patients who were low engagers (class 1) (n=19,930; 36.50%) to those who engaged most frequently with the DHI class 5) (n=5,799; 10.60%). The low engagers, which comprised the largest class of engager, spent less time on the intervention and completed fewer therapy sessions compared to all other classes of engager. However, interestingly this class did not display rapid disengagement from the DHI unlike class 3 (n=13,936; 25.50%) who were high engagers with rapid disengagement. Rather, they displayed a steady disengagement over time. Chien et al. (2020) concluded that while patients in all five classes showed some level of improvement in mental health – what they referred to as ‘a dodo bird effect’ – class 5 engagers showed the greatest improvement (66.90%) compared to class 1 (39.50%). They also suggested that effective engagement may be impacted by the parts of an intervention engaged in by patients, as much as engagement with all elements of an intervention.

Another study from the ProACT project which used machine learning techniques and data mining, analysed how 60 multimorbid older adults using the ProACT platform to monitor their symptoms and well-being with TTN support, engaged with the platform over a 12-month period. Sheng et al. (2024) conducted principal component analysis and clustering analysis to group the participants according to their levels of engagement – the typical (i.e., those who engage with it on an average basis) users, the least engaged users and the highly engaged users. The findings revealed that there were three main factors that influenced engagement, namely, whether the same device was used to submit health and well-being readings, the number of manual steps needed to take a reading and the participants’ daily routines. Age, sex and the types of chronic conditions did not impact on the participants’ engagement. Further findings also indicated that higher levels of engagement with ProACT had the potential to improve outcomes for the participants such as reducing symptom exacerbation and increasing physical activity, whereas the least engaged group of participants showed decreased health and well-being outcomes.

An earlier study by Sheng et al. (2022) using the same cohort of participants as that in their 2024 study focused on user retention, frequency of taking readings, intervals in monitoring and patterns of daily engagement. Participant retention was high with eight withdrawals recorded, and of these withdrawals, some participants had used the ProACT platform for over 100 days. Further, engagement with the platform was also high with over 80% of participants using it for over 200 days and many using it for more than 300. The most frequently submitted data were the sleep and activity data that came from a smart watch worn by the participants – both were submitted six times per week – which the authors attribute to this device requiring minimal interaction on behalf of the user. The least frequently submitted were the weight and self-report (i.e., symptom and well-being) data not captured by a digital device which were submitted mainly once per week. The largest interval in data collection was also with the self-report data, with the smallest being for blood oxygen and blood glucose levels. In conclusion, the morning time was when the majority of DHT interactions took place, with 8am the most common time for participants to take their weight and 10am being the most common time for submission of symptom readings.

O'Connor et al. (2016) conducted a systematic review of 19 qualitative studies that researched the facilitators and barriers that affected patient engagement and recruitment to DHIs. Four major issues that affected engagement were identified, which were: motivation; personal life and values; the engagement and recruitment approach; and the quality of the DHI. In regard to motivation, patients who wished to be healthy were more likely to engage with DHIs, as they perceived that doing so was a way of preventing the onset of illness. The second issue that emerged related to personal life and values, specifically patients who felt that technology was relevant or could be tailored to their needs so that it fitted into their lives were more likely to sign up to a DHI. Thirdly, patients who either had support from family or friends, or received personal recommendations about a particular DHI were also more likely to be recruited to a DHI and remain engaged with it. Finally, patients engaged with DHIs when they believed that a digital product or service provided higher quality health information or allowed them to communicate more easily with their HCP. The barriers to engagement and recruitment described by the authors included poor understanding of technology resulting in seeing little value in a DHT, and suspicion of technology as disruptive or not intended for health care. Privacy and the security of personal health information were reasons why patients did not engage with the technology.

A systematic review of 29 studies undertaken by Escriva Boulley et al. (2018) identified the DHI functionalities that cancer patients engaged with. Videos and reminder features were the most popular functionalities in terms of higher engagement scores, while interacting with HCPs through sending messages or pictures was the most used DHI feature, even though this was seen as burdensome to use by patients. Further, patients raised concerns with the DHIs such as technical issues, problems with usability, and aesthetics (i.e., the look and comfort). Finally, a need for training and time to learn how to use the DHI was also expressed by patients.

Older adults also face similar barriers when engaging with DHT but they face additional difficulties related to the ageing process. For instance, Wilson et al. (2021) report that age related physical health barriers to technology engagement are very prevalent. Physical health barriers include problems with viewing videos on small monitors; difficulties in processing visual information; problems with seeing in poor light or near distance; adjusting to screen glare on devices; poor hearing which present problems with hearing alerts or prompts; and finally, hand tremors which impacts fine motor control and hence, makes pausing and stopping videos or changing text font size for easier reading problematic (O'Reilly et al. 2022; Nymberg et al. 2019; Cajita et al. 2018; Nguyen et al. 2017). Other health problems such as the presence of cognitive impairment can affect attention span, executive functioning and memory, in particular remembering passwords and acquiring new information (Nymberg et al. 2019; Borg et al. 2015). Further, older adults encounter problems with DHT such as a lack of flow and logic with programme content, difficulties with uploading information and opening programme links, a lack of experience with computers and other types of technology, and not having access to the internet (O'Reilly et al. 2022). In addition, the authors note that older adults perceive technology as being impersonal and lacking empathy which results in them feeling little more than a statistic; they lack confidence and the ability required to try new things; and, they also feel the need to retain control over personal information, expressing a lack of trust in sharing that information with others.

Another often-cited barrier to engagement with DHT for older adults is the lack of both technical and social supports, i.e., support received from either HCPs, peers or family members (Wilson et al. 2021). Not having enough training and support to use DHT, and help to troubleshoot technology issues is mentioned in the literature (O'Reilly et al. 2022; Pywell et al. 2020; Nymberg et al. 2019; Cajita et al. 2018). Indeed, Pywell et al. (2020) contend that technical support is, in fact, crucial for older adults' not only initial engagement, but also their continued engagement with DHT. van Middelaar et al. (2018) emphasise the need for human support when engaging older adults in the use of technology. Indeed, patients frequently prefer support from their HCP with their self-management, rather than managing their conditions alone (Pichon et al. 2020). Moreover, the authors argue that a lack of HCP support can be damaging to the patient. However, as noted previously, HCP support is not always available when needed by patients, for reasons such as time constraints, HCPs feeling burdened by having to monitor patient data or not wanting to, and the conflict between what a patient expects from their HCP and what the HCP can provide (Doyle et al. 2022). Further, having to rely on family who often show a lack of patience and understanding for older relatives trying to learn the technology is far from ideal, and in fact may be a barrier to engagement (Zibrik et al. 2015). Meanwhile, Pywell et al. (2020) report that a lack of face-to-face engagement is a major deterrent in engagement with technology, and that the absence of interpersonal communication reduces the therapeutic effect of the technology they use.

Lorig and Holman (2003) stress that it is important to understand how people engage with DHT because health self-management is a life-long undertaking in which people endeavour to manage their health by exercising, eating healthily or managing illnesses. In light of the impact that multimorbidity has on those who live with it as discussed previously, the benefits that PwMs can obtain from the use of DHT for the self-management of their conditions, and the issues surrounding digital health engagement – particularly for older adults which point to a requirement for additional support which is lacking – there is a need for further investigation into how PwMs can be supported to remain actively engaged in the self-management of their health.

In summary, the final theme in this review explored the concept of patient engagement. A brief explanation of its attributes was given and the impact that it has on patients' health outcomes was explored. Communication was found to be a positive factor in increasing active patient participation in health care. The theme ended by examining engagement with DHT and the issues that affect engagement.

2.6 The role of the TTN in supporting PwMs

As highlighted in the previous section of this thesis, the literature points to the myriad of challenges that PwMs face daily in managing their conditions such as medication management, frequent hospitalisations and a lack of integrated care. The need for various types of support has been identified and another form of support could lie in PwMs having access to a telephone nurse-led triage service. The following section of this thesis investigates the role of nurse-led telephone triage services in providing support for digital health self-management and the issues they face in providing support.

2.6.1 How TTNs support digital self-management

Remote monitoring of health (telehealth) is the range of interventions that enable the exchange of health data and other appropriate information, between the patient and their HCP which helps with the diagnosis and management of health conditions (Sanders et al. 2012). According to van Houwelingen et al. (2016), using technology to provide remote health care is a key method of satisfying the increasing demand for it amid the declining population of HCPs. For example, videoconferencing or telephone triage services can be used to:

- Monitor vital signs e.g., blood pressure, blood oxygen levels, blood glucose levels or weight through self-management devices;
- Respond to alerts arising from the devices;
- Monitor movements in and around the patient’s home;
- Provide referrals when necessary to appropriate HCPs, ensuring that the patient accesses the correct level of care;
- Provide consultations on issues such as wound assessment; and,
- Educate patients about their conditions.

However, Jang-Jaccard et al. (2014) caution that telehealth is only effective if users (nurses and patients) know how to use technology properly. Indeed, van Houwelingen et al. (2016) claim that most nurses are either not trained or are insufficiently trained to use technology which results in telehealth failing to reach its full utilisation potential.

A four-round Delphi-study was conducted by van Houwelingen et al. (2016) to elicit what nursing telehealth entrustable professional activities are relevant for TTNs and what competencies they need to perform these activities successfully. The panel comprised 51 experts – nurses, university nursing faculty, patients and technicians all familiar with telehealth – who identified 14 nursing telehealth entrustable professional activities which included supporting patients to use technology, training patients to use technology to strengthen their social network, providing health promotion, triaging incoming calls and alarms, and, analysing and interpreting incoming data from patients' self-management devices. Meanwhile, communication skills, coaching skills, an ability to combine clinical experience with telehealth, clinical knowledge, ethical knowledge and a supportive attitude were identified as the most important competencies for TTNs. However, the panel was comprised of experts solely from the Netherlands and hence, their findings may be difficult to generalise to other populations. Nevertheless, this study sheds light on what activities and skills are necessary for TTNs to be effective in providing the right health care to their patients.

One study looked at TTNs' own perceptions of their role. Onubogu and Earp (2013) evaluated 70 TTNs' perceptions of their role with regard to making safe assessments, clinical decision making, their practice standard (i.e., using standards and protocols to ensure high quality interventions with patients) and satisfaction with their job. The majority (60%; n=42) of participants were satisfied with the safety of their assessments and felt comfortable making them over the telephone. More than two-thirds of respondents (65.80%; n=46) were also satisfied with their practice standard, however more than half (52.80%; n=37) were less satisfied with their confidence in making decisions. Finally, 46% (n=32) of the TTNs reported feeling happy in their jobs. Onubogu and Earp (2013) asserted that their results highlighted the importance of understanding the demands of the TTN's role in order to ensure quality and safety in the delivery of telehealth. However, the sample's gender distribution was severely skewed as there was only one male participant, which significantly limited generalisability. In summary, this section has examined the role of the TTN in supporting patients to self-manage their conditions. In the following section, the challenges that TTNs face in carrying out their role will be discussed.

2.6.2 The challenges of the TTN role

As identified previously in this literature review, telephone triage is a complex process of identifying a patient's health concerns, quantifying the level of urgency and giving advice (Huibers et al. 2011) while also ensuring the safe, timely and appropriate disposition of their symptoms to another clinician when necessary (Wheeler 2009). A disposition (or referral) is defined as an instruction given to a patient by a clinician about the time, place and person who will evaluate and/or treat their symptoms (Wheeler et al. 2015). This is to avoid delays in care, evaluation, diagnosis and/or treatment, thus ensuring that patients are seen before the escalation of symptoms. Some of the challenges that TTNs face in undertaking their role are: (1) decision making; (2) safety issues, (3) communication with patients; and (4) patients' adherence to advice given. These issues will be discussed in turn below.

2.6.2.1 TTN decision making

Telephone triage has been found to be an effective way of managing workloads in various health care settings (Varley et al. 2016). It has been adopted globally as a way of coping with increasing service delivery demands in primary and emergency health settings (Tariq et al. 2017). TTNs base their decisions on a combination of experience, education and the nursing process (Rutenberg and Greenberg 2012; Wheeler 2009). Telephone triage requires rapid and accurate processing of information given by callers to ensure those decisions are safe and appropriate Allan et al. (2014).

Varley et al. (2016) conducted quantitative research with 35 nurses in primary care settings who were trained in the use of CDSS, to investigate the association between 10 nursing characteristics and patients being recommended for follow-up within the practice through face-to-face, telephone or home visit contact by either a GP or nurse. The 10 nursing characteristics were: gender; age; ethnicity; qualifications; level of experience; job role; ability to prescribe; previous triage experience; previous CDSS usage; and preparedness for triage. The authors found that 86% of patients were recommended for follow-up within the practice. Further, a significant correlation between nursing role and preparedness for triage and the probability that a patient would be recommended for follow-up within the practice was found, with the more highly qualified nurse practitioners being less likely to recommend patients to further follow-up within the practice than the Practice Nurses. Varley et al (2016) posited that this may have been because of the advanced training undertaken by nurse practitioners which rendered them as more confident and also resulted in them feeling more prepared for their role as triage nurses. Additionally, nurses – both nurse practitioners and Practice Nurses – who reported themselves as more prepared for their triage role, were more likely to deal with the call definitively, i.e., without need for further consultation.

A study undertaken by Huibers et al. (2012) explored the association between the quality of telephone consultation and appropriate decision making. A sample of 6,739 consultations with 623 triage nurses across the Netherlands was analysed for quality, nurse-assessed urgency and the appropriateness of TTNs' decision making in relation to urgency, follow-up advice and timing. The authors found that 91% of decisions were appropriate for urgency, 96% were appropriate for follow-up advice and 95% were appropriate for timing. A positive association was found between higher quality of consultation and appropriate decision making, while poor consultation quality resulted in an increase in the estimation of urgency. Higher urgency estimations led to a decrease in appropriate decisions and an increase in follow-up advice and timing. However, the researchers questioned whether good quality consultations are as important as appropriate decision making in the event of highly urgent telephone contacts. They cautioned that TTNs should take extra time in urgent consultations to conduct a proper assessment which could prevent over-triage (i.e., overestimating the urgency of the case) with its knock-on effects on capacity and treatment delays. Making the right treatment decision for the patient is a crucial part of the TTN's role because of the impact it can have on the safety of callers, with potential outcomes being moderate or severe harm, or even death. Safety issues are discussed in the following section.

2.6.2.2 Safety issues

Patient safety is an ever-present concern in telephone triage and may be compromised if there is an underestimation of the seriousness of the case, particularly if the patient is not seen in time or if they are not seen by a physician (Huibers et al. 2011). Further, another issue is the safety of the advice provided by triage services themselves. Lake et al. (2017) undertook a review of 10 systematic reviews in order to determine the scope, consistency and generalisability of findings in relation to the safety of telephone triage services, as part of a review which also examined governance and quality concerns. Their findings related to the safety of such services, revealed that they were for the most part deemed to be safe when comparing the frequency of adverse events, errors and hospitalisation rates, and as safe as traditional care. However, the authors pointed to the fact that safety can be a difficult concept to measure as patients already unwell or at risk, may be more prone to adverse events, which was not the fault of the service.

A narrative review of 19 studies conducted by Wheeler et al. (2015) examined the differences in safety among four decision-maker groups – nurses, doctors, emergency medical dispatchers and clerical staff – in carrying out telephone triage. Each group's decision-making process was analysed in terms of being a safe match to the triage task they undertook, based on each group's appropriate referral rate percentages. The authors defined safety as being concerned with appropriate referrals (the right time, the right place and with the right person). Their findings revealed that nurses had the highest appropriate referral rate (91%) followed by doctors with an appropriate referral rate of 82%. Further, telephone triage was found to be least safe after office hours when doctors and clerical staff typically managed calls.

Another aspect of patient safety is related to the usability of the decision support system being used by TTNs. TTNs are required to accurately record information while conversing with patients, therefore the system they use needs to minimise the risk of data entry or interpretation errors that may happen during the triage process (Tariq et al. 2017). Their study evaluated the usability of a decision support system for TTNs through discussions with stakeholders, in-depth heuristic analysis and interviews with TTNs (n=9). The system they assessed was a purpose-built support software called 'Call Enhance Call Centre' (CeCC). This system required TTNs to select and proceed with appropriate guidelines to deal with the caller's concerns (e.g., medication, pregnancy). The heuristic analyses comprised a 2-hour long demonstration of the CeCC system followed by independent expert analysis of it using a list of ten usability heuristics (consisting of a set of guidelines, noting the severity of each usability problem and where in the system it occurred). The authors discovered 41 unique usability issues that may have impacted on the quality and efficiency of data entry. The issues with the greatest impact included: the system's efficiency of use which affected the TTNs' ability to retrieve information; difficulties with searching for appropriate guidelines to deal with patients' problems; and poor system interface design which resulted in poor visual quality.

2.6.2.3 Communication with patients

Communication is a vital component of the TTN's role in ensuring safe health care provision to patients, and underpins consultations, as TTNs with good communication skills recognise patients' problems more accurately (Andrews 2014; Purc-Stephenson and Thrasher 2012). Murdoch et al. (2015) examined the impact of using CDSS on TTNs' conversations with patients. 22 audio-recorded TTN and patient interactions from one English GP practice were analysed. In addition, 10 video-recordings of the TTNs using CDSS were evaluated. This study found that using CDSS to triage patients forced the TTNs to reduce patients' problems to one or more symptoms that could be measured and documented by the system. Patients presented with diverse symptoms, knowledge of how triage consultations worked and communication skills which TTNs needed to negotiate in order to deliver the appropriate care. Therefore, TTNs required high levels of clinical and technology use skills, and to be adept in their communication with patients to ensure safe triage outcomes.

A study by Ernesäter et al. (2016) described TTNs and patients' communication and the response of TTNs to patients' expressions of concern about their conditions. The sample of 25 calls made by different patients was handled by 21 different TTNs. Patients had received a less urgent level of care than they expected and/or were not in agreement with the TTNs regarding the level of care recommended to them and hence, represented a challenge for the TTNs. The results revealed that the TTNs did not always follow the 'dialogue process' which stresses the importance of TTNs ensuring that patients understand the care recommended to them. Only seven out of 25 calls obtained the patients understanding, which the authors argued could be deemed a threat to safe telehealth and further still, the agenda being nurse-driven instead of patient-centred. In addition, the majority of responses to patients' concern (n=17) was a closed medical question and there was a lack of exploration of the reasons for patients’ concerns. More concerning still was the fact that patients’ concerns were met with disapproval from the TTNs, although this only occurred in three of the calls.

Another study which looked at communication was conducted by Graversen et al. (2020). The focus of their quantitative study was to compare the quality of communication in an out-of-hours triage service conducted by TTNs, GPs and physicians with different specialities. A total of 1,294 calls were randomly selected and of these, TTNs conducted 430 calls, GPs conducted 423 calls and physicians conducted 441 calls. The authors found that overall, over 20% of calls were judged to have poor communication quality, categorised as ‘structuring of the conversation’, ‘mastering questioning techniques’, ‘summarising’ and ‘paying attention to the caller’s experience’. The quality of communication was associated with accurate triage. Communication quality was higher in calls triaged by TTNs compared to those triaged by GPs. However, the quality of GPs calls compared to physicians was significantly higher. Finally, calls triaged by TTNs and physicians were longer and deemed to be less efficient.

An earlier study by Vilstrup et al. (2019) also examined communication and safety issues in out-of-hours triage service, however, this study concentrated on the communication characteristics of nurse-led and GP-led triage only. Interestingly, similar to Graversen et al. (2020), TTNs in this study had longer conversations with patients and also asked significantly more questions (9 vs 5). They also allowed patients more spontaneous talking time. Compared to TTNs, GPs appeared to be more likely to give an emphatic answer to patients who expressed concern, whereas in 36% of calls, TTNs either consulted with a physician or transferred the call to them.

2.6.2.4 Patients' adherence to advice given

The intention of a patient to comply with advice given is an important outcome of telephone triage services and demonstrates such services' effectiveness in dealing with patients' health issues (Purc-Stephenson and Thrasher 2012). Whilst middle and older-aged patients use such services frequently to access treatment referrals and health information, there is however, an issue surrounding adherence to advice given (Tran et al. 2017). Impacts of non-adherence include the reduced ability of telephone triage services to limit demand for access to emergency department (ED) services (McKenzie et al. 2016), in addition to the potential of leading to poor health outcomes for patients (Tran et al. 2017).

Adherence rates vary widely according to extant research, with some researchers estimating it to be less than 65% (De Coster et al. 2010) whereas others claim it to be nearly 90% (Jácome et al. 2019). However, comparing adherence rates is difficult, as much of the research is dated, focuses on different service availability (during work hours or out-of-hours) and differs in the type of triage model (nursing, medical or non-medical staff) (Siddiqui et al. 2019). De Coster et al. (2010) found that the rate of adherence was influenced by the type of advice given, with patients more likely to follow a recommendation to go to their ED or administer self-care rather than attend their GP. Further, the findings in a systematic review conducted by Carrasqueiro et al. (2011) concurred with this, and attributed variance in adherence rates to factors such as the patient's original intention (what they had intended to do if they had not contacted the triage service), the nature of their complaint, age and level of income.

Purc-Stephenson and Thrasher (2012) conducted a systematic review which investigated the extent to which patients complied with advice received from TTNs and which factors potentially influenced their adherence. The 13 studies analysed found that overall, 62% of patients complied with advice, but adherence varied by the level of the care recommended to them, similar to De Coster et al.'s (2010) and Carrasqueiro et al.'s (2011) findings. For example, a low adherence rate of 44% was reported for advice to see a GP, which increased to 63% for a recommendation to use emergency services and 79% to administer self-care. Patient perceptions – i.e., their perceived threat of illness, their expectation of care and their trust in the advice received – and the quality of TTN's communication were the factors that influenced patients' adherence rates.

Another systematic review also looked at adherence rates, this time undertaken by Blank et al. (2012). 26 studies were included in the review, with an overall adherence rate reported of 75%, which was higher than the rate observed in Purc-Stephenson and Thrasher's (2012) study. Further, adherence rates followed a similar pattern to those of Purc-Stephenson and Thrasher's, with a lower rate recorded for advice to see a GP (66%), compared to rates for attending an ED (75%) or administering self-care (77%). The authors did however express a note of caution with their findings, as this study was conducted as a Rapid Evidence Review, which excluded grey literature. This may have resulted in a number of relevant articles not being identified and also, introduced the risk of bias by the exclusion of unpublished research.

Tran et al. (2017) assessed the extent to which patients followed triage advice and how this varied according to participants' socio-demographic, lifestyle and health characteristics. This observational study included 8,406 adults aged 45+ years who made 11,088 calls to an Australian health care line. Advice given was: (1) attend ED immediately; (2) see a doctor (immediately, within four hours or within 24 hours); (3) self-care; and (4) self-referral to ED or hospital with 24 hours when given a self-care or low-urgency care recommendation. Rates of adherence to the advice 'attend ED immediately', 'see a doctor' and 'self-care' were 68.60%, 64.60% and 77.50% respectively. In 7% of cases who were given self-care and low-urgency dispositions, self-referral to ED within 24 hours occurred. Patients who had three or more positive lifestyle behaviours (e.g., non-smoker, low alcohol consumption, a minimum of two and a half hours of physical exercise per week and daily recommended intake of vegetable and fruit) had higher adherence rates with the advice to 'attend ED immediately' than those who lived in rural/remote areas and had high levels of psychological distress. Patients aged 65+ years, who worked full-time or lived in socioeconomically advantaged areas were more adherent to the advice to 'see a doctor' than those living rurally/remotely or those taking five or more medications. Further, patients in the 65+ age range were less likely to adhere to 'self-care' advice. Self-referral to ED within 24 hours was most prevalent in patients from disadvantaged areas.

A later study by Gibson et al. (2018) also investigated adherence to telephone triage advice to attend ED in an Australian cohort, in addition to examining the acuity (the level of illness severity) of those patients who attended ED following a call to a triage service. This large qualitative study of more than 629,000 calls revealed that 66.50% of callers were adherent to the advice to attend an ED and similar to Tran et al.'s (2017) findings, 6.20% self-referred to the ED when given a low urgency assessment. In addition, those patients who were referred to the ED were significantly less likely to be assessed as low urgency on arrival there. Another similarity to Tran et al.'s (2017) findings is the fact that people who lived in rural/remote areas were less adherent than their urban living counterparts. An interesting finding from Gibson et al.'s (2018) study was that the more frequently a patient had called the triage service, the less likely they were to be adherent.

In conclusion, this theme has investigated the various challenges that TTN's are faced with in the performance of their duties. Their role has been demonstrated to be a responsible one as they are required to provide accurate health advice while keeping the safety of their patients at the forefront of everything they do. The final theme in this review, that of patient engagement will now be discussed below.

2.7 Literature review summary and research gap

PwMs face a myriad of issues in dealing with their health and it is evident from the literature that has been reviewed and discussed in the review, that self-management plays a key part in improving their health outcomes. In order to achieve those better outcomes, PwMs need to be effective in their self-management, which involves learning how to set health priorities, make daily decisions (Bratzke et al. 2015), and cope over time through a process of trial and error (Miller et al. 2015). As such, self-management of multimorbidity is a lifetime undertaking (Lorig and Holman 2003).

As highlighted in the literature review, effectual self-management of health conditions does not happen in isolation and human support from HCPs, fellow patients, family or friends is an important factor in ensuring the success of PwMs' efforts (Scholz Mellum et al. 2019). This support comes in the form of instrumental support, psychosocial support and emotional support. Instrumental support is characterised as help from HCPs with illness monitoring, shared decision making and discussions around new self-management strategies. Psychosocial support in the form of individual counselling and finally, emotional support from HCPs, other patients and family and friends are also essential for better health outcomes for PwMs (Dwarswaard et al. 2016). However, support from HCPs is not always readily available (Wilson et al. 2021), and support from family members or carers not always ideal (Zibrik et al. 2015). Another form of HCP support – from TTNs – may provide a solution to the problem (Doyle et al. 2022). The authors stress that this dedicated role is especially important for people with multimorbidity in light of the fact that health care systems are far from being able to provide proper patient-centred, collaborative and integrated care. However, this is a novel area of health care where there has been little previous research and consequently, is poorly understood. Such research is especially relevant with the increasing demand in health care, caused in part by the proliferation of chronic disease, allied with a decline in the number of HCPs (van Houwelingen et al. 2016).

The literature review also examined the concept of patient engagement, which is defined as a process that results from the cognitive, emotional and conative actions of patients towards their own health care (Graffigna et al. 2014). The concept is broadly accepted in the literature as having important positive consequences on health outcomes and it will have a significant impact on future health delivery (Higgins et al. 2017). DHT is an important part of multimorbidity self-management, hence, engagement with DHTs is also important for PwMs in overcoming difficulties in the health care system such as cost, access and poor synchronisation between HCPs (Chien et al. 2020; Villalobos et al. 2020; Fortuna et al. 2019; Ng et al. 2019; Escriva Boulley et al. 2018; Hibbard et al. 2017; O'Connor et al. 2016; Reti et al. 2010). However, Yardley et al. (2016) assert that 'effective engagement' is preferable to simply promoting more engagement, given that effective engagement is more likely to achieve intended health outcomes.

Patient engagement is increasingly being seen as important not only to improving patients' health outcomes and quality of life, but also as a way of reducing health care costs that are exponentially increasing as populations age and become burdened with multiple chronic diseases. While there is a plethora of research into multimorbidity, there is little literature on the role that a nurse-led telephone triage service can play in supporting PwMs who are self-managing their conditions through the use of DHTs to engage in their self-management. This is both internationally, and particularly, from an Irish perspective.

Research is therefore necessary into this important issue and this is the gap in the literature that this thesis proposes to fill. The following sections of this thesis examines the conceptual framework used in this study, beginning with a discussion on the nature of theory, followed by a brief examination of conceptual and theoretical frameworks, continuing with an investigation of the framework used herein, and concluding with the rationale behind its choice.

2.8 The nature of theory

A vast number of authors have written about the nature of theory, resulting in many definitions of its character (Brown et al. 2019; Collins and Stockton 2018; Lederman and Lederman 2015; McKenna et al. 2014; Hodges and Kuper 2012; Powers and Knapp 2011; Maxwell 2005; Sutton and Staw 1995; Kerlinger 1986). However, the most fundamental explanation of theory comes from seminal works in the 1960s by Kaplan (1964) and Merton (1967) who argue that it is the answer to questions of *why*. A succinct definition of theory building on those of Kaplan and Merton is offered by Powers and Knapp who state that: “A theory is a set of interrelated concepts that guide thinking” (Powers and Knapp 2011, p.110). The authors further assert that concepts, frequently deemed to be the building blocks of theory, are the key ideas articulated by a theory. Theories are useful as they provide researchers with an effective way of framing questions and interpreting the findings, with strong theories aiding the identification of phenomena to be studied and the questions to be asked (Reed 2018). Further, theory helps to organise ideas and evidence into conceptual structures which assist researchers to understand what they discover in their work (*ibid*.) and are systematically and coherently expressed, resulting in a meaningful whole. (Hodges and Kuper 2012).

According to Kivunja (2018), theory most frequently develops from the long process of research which utilises empirical data to make claims based on deductive and inductive analyses of data. Based on clearly stated conjectures, research observations produce findings that explain relationships in the data which help researchers to create the central propositions from which they can generalise the abstract theory. The relationships that are proposed by a theory's assumptions, conjectures and predictions provide a base for research data which enables the search for meaning in future studies. Further, predictions in the theory provide reasons for research into questions that have not been previously examined (*ibid*.). However, Sutton and Staw (1995) urge caution when discussing what theory is, pointing out that the word may be rendered meaningless, due to being applied to concepts ranging from minor working hypotheses to self-evident systems of thought, which results in obscuring rather than elucidating understanding.

2.8.1 Theoretical frameworks

Theoretical frameworks constitute the theories taken from experts in the field that a researcher uses to provide a theoretical 'coat hanger' for their data analysis and results interpretation (Kivunja 2018). Further, theoretical frameworks can be viewed as the frame that supports the theory of a research study and provides it with structure (Grant and Osanloo 2014; Swanson 2013). The simplest definition of a theoretical framework is that it is an explanation of the way things work. Whatever the source, size or power of the myriad of explanations which exist, they all end with trying to understand certain phenomena (Collins and Stockton 2018). The authors posit that a theoretical framework is the use of theory in a study which in parallel makes explicit the deepest values of the researcher and gives a clearly stated signpost for how the study will manage new knowledge. It is the intersection of:

- Extant knowledge and previously formed ideas about complicated happenings;
- The researcher's epistemological outlooks; and,
- A lens and a methodically analytic approach.

Using these three elements makes theory a valuable aid for the clarity and depth of a study (*ibid*.).

2.8.2 Conceptual frameworks

According to Grant and Osanloo (2014), the terms conceptual and theoretical frameworks are frequently used interchangeably in the literature, however, they are not synonymous. Whilst similar concepts, they are different in approach, style and their use within a piece of research (*ibid*.). Whereas theoretical frameworks evolve from existing theories in the literature that have been tested and validated, and been demonstrated to be acceptable, conceptual frameworks provide an understanding of how the problem of concern can best be explored (*ibid*.). Moreover, Miles and Huberman (1994) classify a conceptual framework as a system of ideas, assumptions and beliefs that guide the research plan, and which sets out core factors, constructs or variables with the presumption that relationships exist between them. An earlier definition from them defines it as: "The current version of the researcher's map of the territory being investigated" (Miles and Huberman 1994, p.33). However, a contrary view is held by Weaver-Hart (1988) who argues that conceptual frameworks are contradictory within themselves, asserting that concepts are abstract, whereas frameworks are tangible. The author settles this contradiction by recognising their inherent usability in research as an approach to organising and supporting concepts and a means of systematically arranging them, while sometimes being revolutionary and frequently being rigid. Leshem and Trafford (2007) clarifies Weaver-Hart's (1988) view by explaining that a conceptual framework can be seen as a way of giving a theoretical overview of proposed research and providing a structure for the procedure involved. Frameworks can be categorised as meta, grand/conceptual model, middle range or practice theories and these categories are examined in the next part of this thesis.

2.8.3 Classifications of theory: from meta to practice theories

Meta –theory: this is about theory and is at the most abstract level (McEwen and Wills 2006). It is a term which refers to a critique or evaluation of theory, resulting in an understanding of it (McKenna et al. 2014).

Grand theories: they may also be referred to as conceptual models (McKenna et al. 2014). Grand theories are less ambiguous and give broad understandings of knowledge, and in nursing, provide general future direction for areas of activity (McKenna et al 2014; Quinn Griffin and Landers 2014). Further, they are not easy to apply or test (McKenna et al. 2014).

Middle range theories: they are the most common type of theory in science and are more focused and less generalisable than grand theories (Reed 2018). They were developed in order to bridge the gap between theory and practice (Fitzpatrick 2014). According to Merton (1968), they have the potential to balance the need for precision with the need to be sufficiently abstract. Middle range theories are less conceptualised, are more limited in scope and are more closely related to research and practice (McKenna et al. 2014). Instead, their emphasis is on specific health and illness challenges or particular patient cohorts (Reed 2018) and also, they guide research and offer direction for nursing (Quinn Griffin and Landers 2014). Further, Smith (2014) states that nursing is enriched by the expansion of such theories.

Practice theories: these theories are often called micro-theories and are articulated in researchable and concrete terms. They are narrow in scope and very specific in their clinical focus. Practice theories relate to the actions that a nurse takes in order to effect a desired change in a patient's condition (McKenna et al. 2014). The following paragraphs discuss theoretical and conceptual frameworks.

2.9. The conceptual framework used in this thesis

This study aims to examine how TTNs support PwMs who are using digital health technologies to engage in regular and sustained self-management of their conditions. This research study uses a conceptual framework to guide the process undertaken to investigate the phenomenon of interest being studied herein, and answer the research question '*would older PwMs engage in regular and sustained digital self-management of their health without the support of TTNs?*'

The chosen framework used herein – The Conceptual Framework for Patient Centered Care (PCC)– (Hudon et al. 2011), consists of four dimensions: (1) the patient as a person; (2) the bio-psychosocial perspective; (3) the therapeutic alliance; and (4) sharing power and responsibility that assess patient-centred care. The framework will now be discussed in the following sections of this thesis.

2.9.1 The background to patient-centred care

Traditionally, health care has been based on a biomedical model of care, and it is still the dominant model of health care today (Rocca and Anjum 2020). Rather than seeing illness as a condition of the whole person, the biomedical model treats the patient's bodily parts in isolation, which may relieve some symptoms, yet fails to get to the cause of the problem. This has been seen in the epidemic of chronic illnesses in Western society such as diabetes, obesity and CVD, where treating them on a physical level without social and psychological interventions has been unsuccessful (*ibid.*). Moreover, in this paradigm, health is seen as simply being the absence of physical signs of disease, and when illness is present, it is always considered as a biological entity, concerning only the physical body. Curing illness is the task of the physician, with the patient playing the passive role of receiver of the cure, instead of being the most important actor in their own healing (*ibid.*). Another criticism of the biomedical model is that it only focuses on identifying and treating illness, resulting in the reduction of illness to being a set of signs and symptoms (Mead and Bower 2000).

2.9.2 What is patient-centred care?

The development of patient-centred care is closely linked to the limitations outlined above in the biomedical model of care (Mead and Bower 2000). Patient-centred care is growing in prominence (Fix et al. 2018) and is now widely recognised as intrinsic to family medicine (Hudon et al. 2011). This is due to the need for a combined biological, psychological and social perspective in order to deal with the full range of problems presented in primary care (Mead and Bower 2000). Reduced malpractice complaints, improvements in HCP satisfaction, reductions in consultation time and medication adherence are benefits for physicians (Stewart et al. 2003; Stewart et al. 2000). Benefits for patients include improvements in emotional health, increased satisfaction levels, a sense of empowerment and a reduction in symptom severity and health care costs (Little et al. 2001). Patient-centred care also offers the possibility of better health care, more efficient health care and as a result, improved health for the general public (Carman et al. 2013).

This approach to health care was introduced by psychoanalyst Michael Balint who coined the term ‘patient-centred medicine’, and was described by Edith Balint as a way of understanding a patient as a unique human being (Balint 1969). The concept evolved from the work of psychologist Carl R. Rogers (1959) who developed the concept of client-centred therapy. However, there is a lack of agreement as to its meaning, which can impede its implementation in health care systems (Pelzang 2010), in addition to restricting conceptual and empirical developments (Mead and Bower 2000). According to Byrne and Long (1976), it is a style of consultation between doctor and patient, where the doctor uses the patient's knowledge and understanding to steer the interactions between them. Laine and Davidoff (1996) argue that patient-centred care is closely aligned with, and responsive to, the needs, wants and preferences of patients. Rogers et al. (2005) elaborate on Laine and Davidoff's stance, stressing that not only does patient-centred care align with a patient's wishes, it also includes the element of shared decision making between patient and physician. This viewpoint is shared by Ponte et al. (2003) who highlight that this process goes way above merely setting health care goals with the patient. A succinct definition is given by McWhinney (1989) who describes the approach as one where "the physician tries to enter the patient's world, to see the illness through the patient's eyes". Indeed, Beach et al. (2006) argue that McWhinney's definition has become the best description of patient-centredness, leading to further development of the concept. Nevertheless, whatever the interpretation given to the concept, its underlying philosophy is that the care giver must understand the patient as a person, rather than being a collection of diseases (Epstein 2000).

Patient-centred care provides care to the patient which takes into consideration their beliefs and values, engages with them, lends support, and addresses their physical and emotional needs (McCormack and McCance 2006). A core aim of the concept is to recognise and place importance upon the patient's view of what is occurring to them (Pelzang 2010). According to McCormack and McCance (2006), it is the duty of the HCP to offer support and clinical expertise while allowing their patient to follow their own path (Figure 3, page 69).

Moreover, Pence (1997) suggests that this care model places patients at the centre of care delivery, ensuring that the right person delivers the appropriate care effectively, and at the right time. Continuity of care is improved, as is the integration of collaboration between HCPs, staff can perform their work in ways that respond best to the needs of their patients and finally, patients are given autonomy over their health care (Frisch et al. 2000; Lathrop et al. 1991; Robinson 1991). However, in spite of the obvious advantages of patient-centred care, nevertheless, there are some drawbacks. First, it assumes that patients are capable of making their own decisions about what kind of care they want and need, especially if they feel overwhelmed with illness (Lutz and Bowers 2000). Further, with the increase in chronic illness and disability in an ageing population, cognisance must be given to the fact that in some cases, patients do not want to take an active part in decision making about their health care (*ibid*.). Second, staff shortages and overwork in clinical settings leave HCPs with little time to sit with patients and understand their health worries (Pelzang et al. 2010; Buerhaus et al. 2005). Third, there is an absence of good teaching models and curricula for HCPs that incorporate aspects of person-centred care such as social and interpersonal aspects (Pelzang 2010). Finally, a health system where patients are quickly handed over to different HCPs in other places of care can cause medical staff to take a narrow task-specific view of their patients' illnesses, and not view their patients as a whole person. This results in fragmentation of care, with HCPs only having limited opportunities to see the progress of their patients through their illness (*ibid*.).

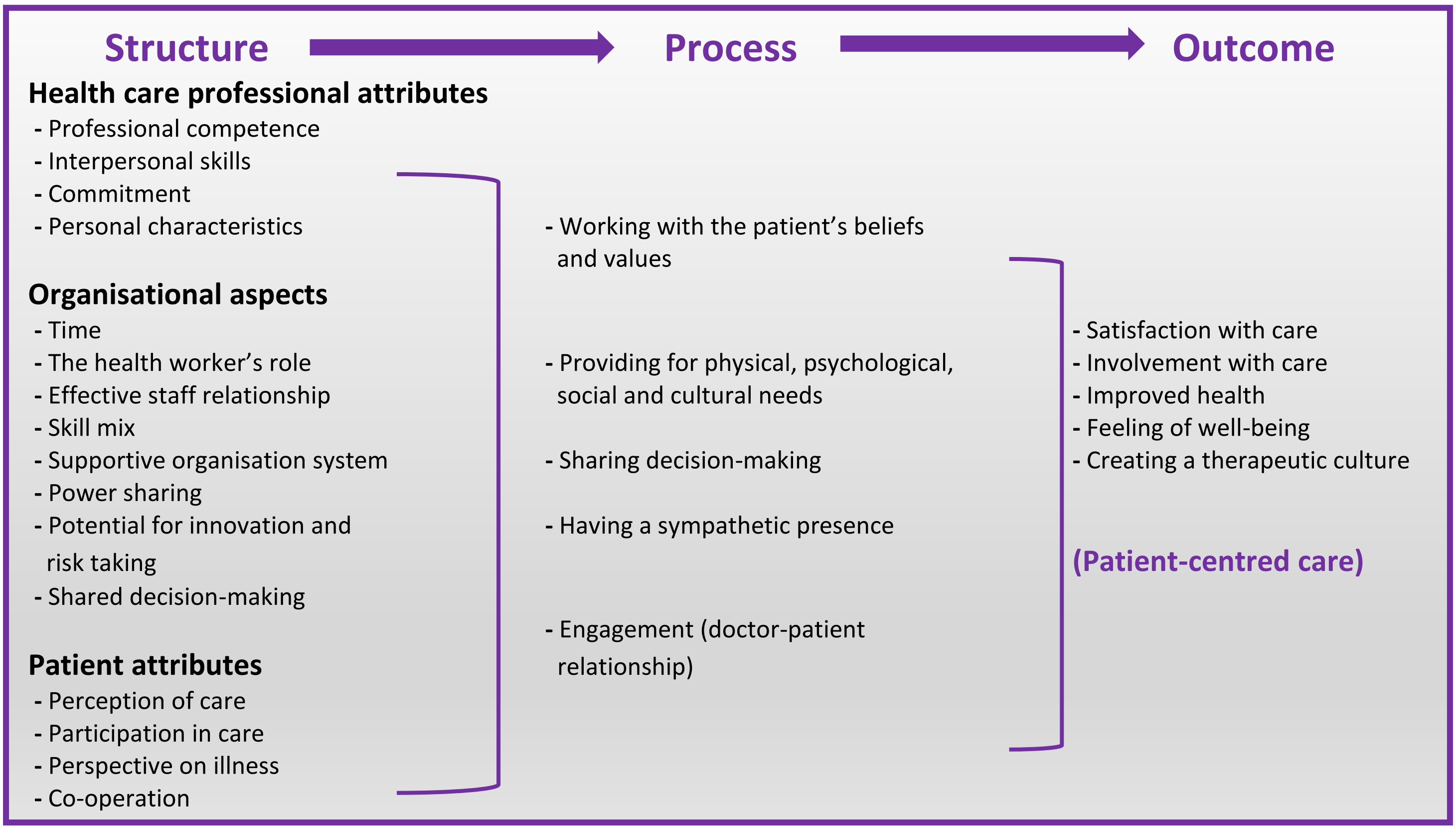


Figure 3: Attributes of patient-centred care practice (McCormack and McCance 2006)

2.9.3 The Conceptual Framework for Patient Centered Care (PCC)

The PCC (Hudon et al. 2011) was developed by the authors following a systematic review of the literature in which they aimed to identify and compare instruments, subscales or items that assessed patients' perceptions of family medicine-based patient-centred care. In the absence of a clearly defined consensual framework in the literature, Hudon et al. (2011) developed their own framework to assess patient-centred care, using dimensions from Stewart et al.'s (2003) model and Mead and Bower's (2000) framework.

The PCC, which is a grand theory, is based on the model of patient-centred care by Stewart et al., integrated with Mead and Bower's conceptual framework of the doctor-patient relationship. It is a combination of the four dimensions of patient centred care common to both Stewart et al.'s model and Mead and Bower's framework. Stewart et al.'s model is the most commonly cited model in family medicine and contains six dimensions which are: (1)

exploring both the disease and the illness experience; (2) understanding the whole person; (3) finding common ground; (4) incorporating prevention and health promotion; (5) enhancing the patient–physician relationship; and, (6) being realistic. Mead and Bower's framework identifies five conceptual dimensions: (1) the bio-psychosocial perspective; (2) `patient-as-person'; (3) sharing power and responsibility; (4) the therapeutic alliance; and, (5) `doctor-as-person'.

The four dimensions in Hudon et al.'s (2011) framework (shown in Figure 4, page 71) are: (1) the patient as a person (how the person experiences their illness); (2) the bio-psychosocial perspective (considering the whole person); (3) the therapeutic alliance (patient-doctor relationship); and, (4) sharing power and responsibility (common ground).

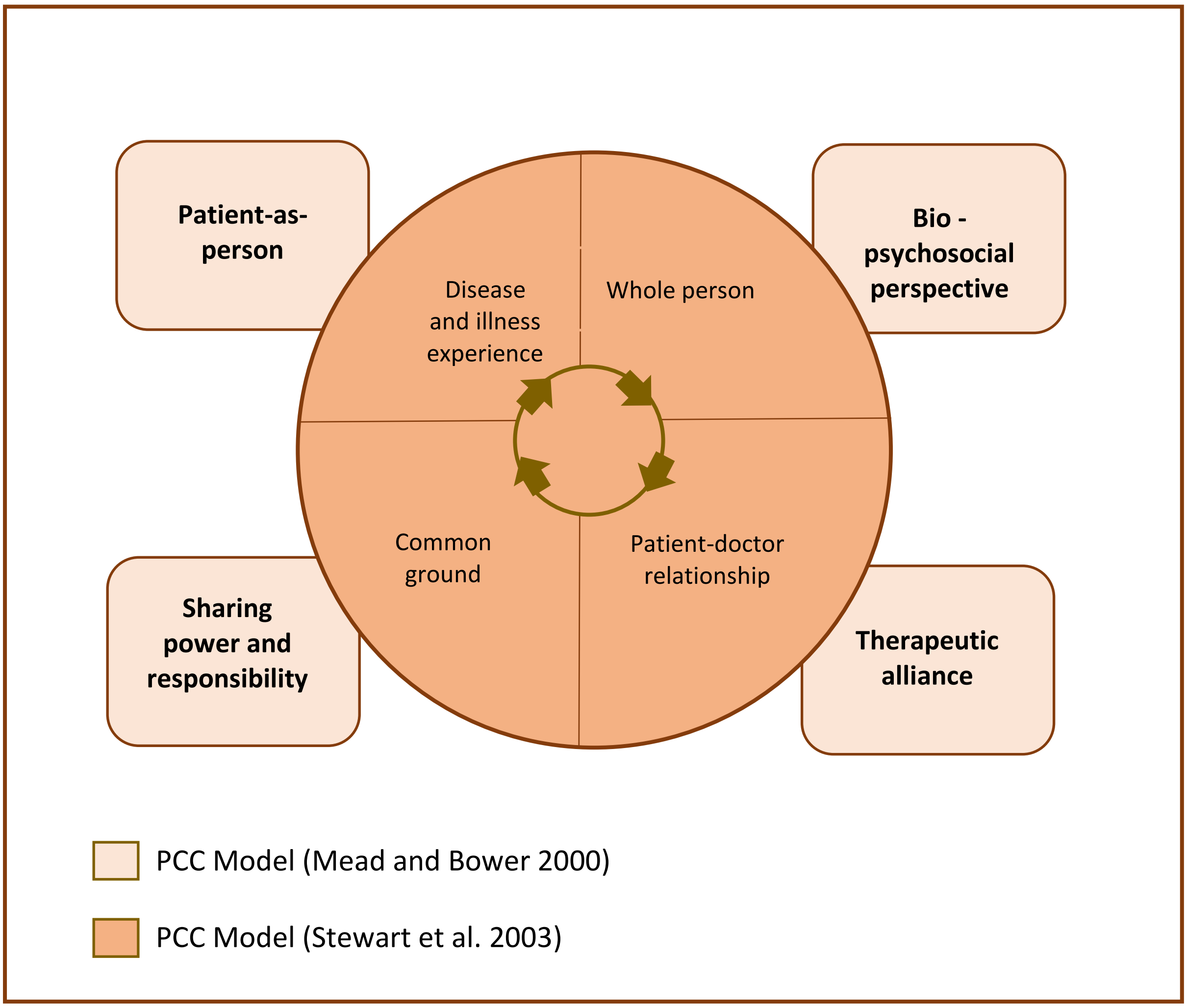


Figure 4: Conceptual framework of patient-centered care (PCC) (Hudon et al. 2011)

2.9.4 Rationale for choice of framework used in this study

The framework developed by Hudon et al. (2011) provides a suitable framework to help to answer the argument raised herein, namely that without the support from TTNs, PwMs would not engage in regular and sustained digital self-management of their health and well-being. Hudon et al.'s (2011) emphasis on the patient-doctor relationship is particularly useful in providing a better understanding of PwMs' self-management of health using DHT, the nature of the relationship between the TTNs and PwMs, and to identify how TTNs can motivate PwM engagement in using DHT for self-management. Whilst designed for assessing family medicine-based patient-centred care, given Hudon et al.’s (2011) framework that is grounded in aspects of the patient-doctor relationship, this theory is equally useful and valid for exploring another type of HCP and patient relationship – that between TTN and PwM. The PCC was assessed for use in this PhD utilising Fawcett’s (2005) criteria for theory evaluation as detailed in Table 2, page 73.

Table 2: *Evaluative criteria and use of the PCC adapted from Fawcett (2005) and Hudon et al. (2011)*

Questions for Evaluation	Responses to Questions
1. Does the theory fit the research that you wish to do**?**	The theory focuses on the relationship between the family practitioner and patient and thus serves as a model of relationship-based health care.
2. Is it readily operationalised?	Yes, the original model is divided into four clearly defined concepts: (1) disease and illness experience; (2) whole person; (3) common ground; and (4) patient-doctor relationship – in this study the PwM-TTN relationship.
3. How well has the theory performed at describing, predicting, and/or explaining the phenomena to which it relates?	The PCC is well cited and has been used in the literature to describe the nature of person-centred care in health care (Liddy et al. 2014; Santana et al. 2018; Scholl et al. 2014) and has also been used in DHT-based patient-centred health care (Doyle et al. 2022).
4. Does the theory flow from the research question?	The research question has the potential to add to the knowledge relating to how the relationship between PwMs and TTNs influences engagement with DHT for multimorbidity self-management. Therefore, the theory guided the development of the research question.
5. Does the theory address the research question?	The theory addresses the research question which is: 'would older PwMs engage in regular and sustained digital self-management of their health without the support of TTNs?'
6. Are the assumptions congruent with the assumptions that are made for research?	The assumptions are congruent with the assumptions that are made for the research in that patient-centred care results in the best outcome for patients by increasing their satisfaction and empowerment and improving their health through reductions in symptoms, and reduces their use of health care resources.
7. Is the theory oriented to outcomes that are critical to patients?	This theory is oriented to outcomes that are critical to patients. It provides a conceptual framework for the delivery of care by TTNs so that when used as described, the TTN advances and supports the PwMs' engagement with digital self-management.
8. Are tools available to test relationships of the theory or do they need to be developed?	There is no tool currently available to test the relationships proposed by the theory.

While the research undertaken for this PhD is based in two disciplines, digital health and the discipline of nursing, this PhD candidate selected a number of theories from the field of nursing as well the fields of patient-centred care and social support to consider for use herein and these are outlined in Table 3, page 75. However, these theories do not address the holistic, therapeutic relationship, experience of sickness, and commonality aspects of the PwM-TTN relationship as comprehensively and succinctly as the PCC is able to. Nor are they as easily transferable for use in the type of research conducted herein. For instance, the frameworks developed by Orem (1971), Peplau (1997) and Watson (1979), while they address the therapeutic relationship between nurse and patient which supports the patient to regain health, they are all meant for use in hospital-based nursing research. Likewise, McCormack and McCance’s (2006) framework, although developed for use in patient-centred care research, is also conceived for use in hospital settings. Meanwhile, Mead and Bower’s (2000) patient-centred framework does not include any dimension relating to disease prevention or health promotion. The final patient-centred framework considered, that of Scholl et al. (2014), contains 15 aspects of patient-centred care that maps onto three levels of health care, and while it is a comprehensive framework, nevertheless, is burdensome to use. Finally, the social support theory whilst it addresses the concept of therapeutic relationships that enhance health and well-being, similar to Mead and Bower it does not contain a concept related to disease prevention, nor does it include the bio-psychosocial perspective or power and responsibility sharing.

Table 3: *Other conceptual frameworks/theories considered for this PhD*

Conceptual Framework/ Theory	Theorist(s)	Theory Premise	Theory Type
Integrative Model of Patient-Centeredness	Scholl et al. (2014)	Framework which identifies the aspects of patient-centred care. 15 dimensions of patient-centeredness such as the clinician-patient relationship, clinician-patient communication, patient as unique person, bio-psychosocial perspective, patient information, patient involvement in care that map onto three levels of health care: micro, meso and macro.	Grand/conceptual model
Interpersonal Relations in Nursing	Peplau (1997)	In this framework, nursing is defined as an interpersonal therapeutic process between trained nurses and patients. In order for the nurse-patient relationship to be successful, three phases must be completed: (1) orientation, the phase where the patient and nurse become acquainted; (2) the working phase where nurses make assessments and plan out care; and (3) the termination phase, thought of as discharge planning where nurses teach patients about symptom management and recovery at home.	Middle-range theoretical framework
Patient-Centredness Framework	Mead and Bower (2000)	The framework identifies five conceptual dimensions of patient-centred care: (1) the bio-psychosocial perspective; (2) `patient-as-person'; (3) sharing power and responsibility; (4) therapeutic alliance; and (5) `doctor-as-person'.	Grand/conceptual model
Person-Centred Nursing Framework	McCormack and McCance (2006)	The framework consists of four constructs integral to patient-centred nursing: (1) prerequisites which focus on the attributes of the nurse; (2) the care environment which	Middle range theoretical framework

		focuses on the context in which care is delivered; (3) person-centred processes which focus on delivering care through a range of activities; and (4) expected outcomes which are the results of effective person-centred nursing.	
Social Support Theory	Various	Framework that focuses on relationships and the interactions within those relationships. The four attributes of social support are: (1) emotional; (2) instrumental; (3) informational: and (4) appraisal support. Social support refers to any process through which social relationships may enhance health and well-being. Important to nursing because it impacts on health behaviour, health status, and use of services.	Middle range theoretical framework
Theory of Human Caring	Jean Watson (1979)	Framework which focuses on how nurses care for their patients and how caring progresses into health promotion and wellness.	Grand/conceptual model
The Theory of Self-Care	Dorothea Orem (1971)	Framework of practices that individuals perform to maintain life functioning or improve health. The theory proposes that people want to act as agents of their own health care and put into action behaviours that enable them to function, develop, maintain health, and achieve a sense of well-being.	Grand/conceptual model

2.10 Chapter summary

This chapter commenced with an examination of the literature surrounding PwMs self-management of their health. Three themes were found – PwM self-management of their health, TTNs support for PwMs with their self-management and finally, PwMs' engagement with their health self-management. The research gap was identified, which is that little is known about the role that a nurse-led telephone triage service can play in supporting PwMs who are self-managing their conditions through the use of DHT to engage in their self-management. The research question was posed which is: '*would older PwMs engage in regular and sustained digital self-management of their health without the support of TTNs?*' The chapter continued with a discussion of theory, its nature, typology, levels and classification. An examination of the conceptual framework selected for use in this study, Hudon et al.'s (2011) PCC, and the rationale for its selection concluded the chapter. Chapter Three which follows will describe the research methodology used in this study.

Chapter 3: Methodology

3.0 Introduction

This chapter explores the methods undertaken to complete this PhD research. The philosophical underpinnings of the methodology will be discussed, followed by an examination of the mixed methods typologies providing the rationale for the choice of study design used in the thesis. The chapter concludes with the details of the study design and mixed methods approach employed to achieve the research aim and objectives.

3.1 Philosophical perspectives

Reed (2018), states that philosophical inquiry increases a researcher's understanding of the issues surrounding the development of their knowledge. A core practice within philosophical inquiry is questioning (*ibid.*), which Smith (2005) succinctly describes as a refusal to take [something] for granted. In undertaking a piece of research, the researcher must first decide upon the methods they will employ to undertake that research, and are also required to place their research within a particular paradigm (Patton 1990). A paradigm, which was given its research meaning in 1962 by Thomas Kuhn in his landmark book 'The Structure of Scientific Revolutions', embodies the values, concepts and practices that define a scientific discipline at a specific point in time (Meleis 2012). Kuhn proposed that science makes sense of the world through paradigms which are based in history and change over time (Reed 2018), and he also stressed that science without theory is pre-paradigmatic, which is to say that it is chaotic, lacking guidance and is not science at all (McKenna et al. 2014). There are four research paradigms: positivist/postpositivist, constructivist/naturalistic, transformative, and pragmatism. The pragmatic paradigm that guides the research approach taken and the methods used herein is discussed in the following section.

3.1.1. The pragmatic paradigm

The pragmatic paradigm which emanated from the work of philosophers Charles Sanders Peirce (1878), William James (1898), and George Herbert Mead (1900) concerns actions, situations and consequences and does not involve antecedent phenomena as in positivistism/postpositivistism (Creswell and Creswell 2018). It focuses on finding solutions to research questions (Patton 1990), with researchers putting emphasis on the problem and using all possible approaches to address it (Creswell and Creswell 2018). According to the authors, pragmatists do not hold the view of the world as an absolute unity, but instead seek different approaches to collecting and analysing data. They believe that certain methods are not exclusive to any one paradigm (Reichardt and Cook 1979) and therefore, do not adhere to the limitations imposed by particular paradigms (Creswell and Creswell 2018).

Pragmatism forms the philosophical basis of mixed methods research which according to Hanson et al. (2005) is led by philosophical assumptions that enable the mixing of quantitative (deductive) and qualitative (inductive) approaches. Creswell and Creswell (2018) suggest that it is the use of both quantitative and qualitative data which gives the greatest understanding of a research problem. Pragmatists use abductive reasoning to move between induction and deduction by firstly turning observations into theories and subsequently analysing those theories through action (Morgan 2007). Abductive reasoning was first advanced by Peirce, ‘the grandfather of pragmatism’ in 1878. Abduction begins with an observation and looks for the simplest and most likely reason for that observation and while proffering a plausible conclusion, does not positively verify it. It can be said that abduction infers the best explanation of a result (Sober 2013).

However, pragmatism has its critics who have criticised it for being ‘too permissive’ as it gives a researcher too many options and allows too many philosophical stances (Rescher 2000). Another criticism raised by Feilzer (2010) concerns possible difficulties in choosing suitable methods to research a multi-layered problem which are capable of capturing all the layers to be measured or observed. The next section of this chapter continues with an examination of mixed methods research design, which is the research design used in this study.

3.2 Mixed methods research

Mixed methods research integrates qualitative and quantitative data within a single study (Halcomb and Hickman 2015) or in a series of studies that examine the same phenomenon (Leech and Onwuegbuzie 2009). Pluye and Hong (2014) assert that mixed methods research unites the strengths of qualitative and quantitative research and offsets any shortcomings of either approach. It presents researchers with an alternative methodological approach which allows for a detailed exploration of complicated phenomena in a more comprehensive way than can be achieved by either qualitative or quantitative methods alone (Halcomb and Hickman 2015; Andrew and Halcomb 2012; Simons and Lathlean 2010). Further, this research method allows for a more complete utilisation of the findings than qualitative or quantitative analysis alone (Zhang and Creswell 2013; Glogowska 2011). Mixed methods research has been referred to as ‘the third research paradigm’ as it is capable of bridging the gap between the other two research paradigm extremes – qualitative and quantitative – providing an effective middle solution to many research questions (Johnson et al. 2007).

This research design originated in the social sciences but is also widely used for research in health and medical science fields including nursing, social work and mental health (Wisdom and Creswell 2013). It was perceived as being an effective method of research because qualitative and quantitative methods are inherently biased and contain limitations, and mixed methods would neutralise these problems (Creswell and Creswell 2018). Further, according to Giddings (2006, p.196), combining qualitative and quantitative findings would provide increased proof and more certainty, resulting in greater confidence in the 'truth value' of the outcomes.

Mixed methods research has existed since the early 20th century, (e.g., Hollingshead 1949; Jahoda et al. 1931; Lynd and Lynd 1929), but was not formally recognised as a method until Campbell and Fiske (1959) (Johnson et al. 2007). These researchers introduced the concept of triangulation, where more than one method is used to validate the fact that variances in the data are the result of the underlying phenomenon and not the qualitative or quantitative method used for data collection (*ibid.*). While Webb et al. (1966) were the first researchers to use the term triangulation, in 1978 Denzin was the first investigator to explain how to triangulate findings (Johnson et al. 2007; Giddings 2006). Fast forward to the 1990s, when a marked growth in interest in mixed methods research was partly driven by the necessity to provide value for money research – 'doing more with less' – and also to produce evidence-based research that can be used in policy decision making (Giddings 2006, p.196). Global ageing with the increase in chronic and complex diseases impacting on health budgets has resulted in researchers facing increasingly difficult research problems (Halcomb and Hickman 2015; Glogowska 2011), and in addition, a need to find methods of investigation that satisfactorily address these multidimensional issues (Bowers et al. 2013; Glogowska 2011; Andrew and Halcomb 2006).

Critics of mixed methods research such as Smith and Heshusius (1986) and Sandelowski (2003) contend that the qualitative and quantitative paradigms are so diverse that they cannot be combined, with Guba and Lincoln (1988) explaining that this is because their epistemological and ontological perspectives are so different. De Lisle (2011) and Creswell (2003) highlight the fact that even well-designed mixed method studies do not always yield trustworthy results. In addition, Giddings (2006) argues that rather than being inclusive, there is a danger that mixed methods may in fact continue the dominance of the positivist paradigm and marginalise constructivist research. The author contends that the thinking in mixed methods research seldom has a constructivist world view, with most studies using the analytic and prescriptive style of positivism, albeit also having a more moderate postpositivist aspect. Further, there is also a potential risk that mixed methods research is being adopted unquestioningly by a new generation of researchers, who ignore the considerable philosophical differences between the two paradigms (Sale et al. 2002), those differences being seen as merely technical differences (Smith and Heshusius 1986).

3.2.1 Strengths

There are numerous reasons why a researcher chooses mixed methods research and it has much to offer in health research. The most frequently voiced arguments in favour of it are that it gives ‘a rounded understanding of process and outcome’ (Bazeley 1999, p.284), and that it increases the certainty of results (*ibid*.). Mixed methods can answer a wider range of questions because the researcher uses more than one method or approach (Johnson and Onwuegbuzie 2004). Wisdom and Creswell (2013) acknowledge that it supports the collection of rich and comprehensive data, it facilitates the comparison of qualitative and quantitative data, thus enabling the understanding of contradictions in findings between the two approaches and finally, it offers a voice to participants, ensuring that their points of view are embedded within the research results. A narrative and pictures can be used to explain numbers, and numbers can be used to add accuracy to narrative and pictures (Johnson and Onwuegbuzie 2004). Risjord et al. (2001) point out that by combining methods, new ways of investigating a particular problem can be found. Other strengths of the approach include using qualitative research to develop hypotheses which can be tested with a follow-up quantitative study and, using a qualitative study to develop questionnaires for use in a subsequent quantitative piece of research (Doyle et al. 2009). Further, Giddings (2006), acknowledges that using a mixed methods design can play a role in attracting research funding. This is apparent in health sciences where interdisciplinary research between medicine and nursing is becoming more frequent as funding agencies encourage collaboration on large projects between the disciplines (Doyle et al. 2009).

3.2.2 Limitations

While mixed methods research has much to offer, there are limitations. For instance, issues may occur with the point at which the data is integrated – at the analysis stage or interpretation stage – or indeed, the data may not be integrated at all, particularly during analysis and discussion (Irvine et al. 2020; Wisdom and Creswell 2013). Another weakness is that studies using this approach are challenging to implement and may be difficult to plan and conduct (Wisdom and Creswell 2013). It can be difficult for a researcher to conduct qualitative and quantitative research concurrently and this approach may need a team to do this (Johnson and Onwuegbuzie 2004). In addition, a researcher must learn about multiple methods and approaches and understand how to integrate them properly (*ibid.*). In conclusion, mixed methods research is labour intensive and requires greater resources and time to carry out in comparison to single method studies, particularly if the study uses a sequential approach (Ivankova et al. 2006; Wisdom and Creswell 2013). The following section will discuss the types of mixed methods research design and explore this study's choice of design, multiphase mixed methods.

3.3 Design typologies

Since the 1990s, a myriad of mixed methods designs has been conceptualised, which makes choosing one onerous (Leech and Onwuegbuzie 2009), leading the authors to highlight the necessity for design typologies, which provide researchers with guidance and direction for their study design. Typologies are also a useful means of conceptualising the relationship between a study's qualitative and quantitative paradigms (Alavi et al. 2018). There are currently approximately 15 typologies in existence, ranging from simple to more complex, developed by researchers including Kettles et al. (2011), Leech and Onwuegbuzie (2009), Morse and Niehaus (2009), Teddlie and Tashakkori (2009), Creswell and Plano Clark (2007), Creswell (2003) and Morgan (1998). These typologies have been drawn from the disciplines of evaluation, nursing, public health, education policy and research, and social and behavioural research. Although authors use varying terms to describe the concepts, there is a considerable overlap in the types of design (Creswell and Creswell 2018). Further, while many real life research situations do not exactly fit these design typologies, nevertheless they provide researchers with a framework to understand the different ways that research can be conducted (Guest 2013). Examples of the core typologies are briefly described below.

Convergent: this design is a single-phase approach in which the researcher collects qualitative and quantitative data at the same time and analyses them separately. Integration takes place during the interpretation of the results stage (Guest and Fleming 2015; Doyle et al. 2009), and are compared to ascertain whether or not they confirm each other (Creswell and Creswell 2018). The main assumption of this design is that while qualitative and quantitative data give different information, together they provide results which should be the same (*ibid.*).

Embedded: this is a complex design in which qualitative, quantitative or combined data are collected, with one data set being embedded within a larger qualitative or quantitative design, theory or methodology (Creswell and Creswell 2018; Guest and Fleming 2015). Its use is appropriate when one type of data is secondary to the other and would not be significant if not embedded within the primary data set (Edmonds and Kennedy 2017). It can also be used if the researcher cannot give equal priority to qualitative and quantitative data or has little experience with one of them (*ibid*.).

Multiphase: in this design which is the choice for this PhD's research, concurrent and sequential phases of qualitative and quantitative data are collected over a period of time and combined with the implementation of projects within an overall programme of study (Guest and Fleming 2015).

Sequential explanatory: this is a two-phase data collection design, with the quantitative data collected and analysed first, the results of which are used to plan for or add to the follow-up qualitative phase (Alavi et al. 2018). The quantitative phase's results usually determine the type of participant that will be purposefully selected, and types of questions to be asked. The quantitative and qualitative databases are analysed separately and subsequently, the two databases are combined. This is the point of integration in this design (Creswell and Creswell 2018).

Sequential exploratory: in this design, firstly, qualitative data are collected and analysed. Subsequently, quantitative data are collected and analysed, and then both sets of data are integrated at the level of interpretation (Alavi et al. 2018).

Sequential transformative: either qualitative or quantitative data are collected first, with the results being integrated in the interpretation phase (*ibid*.). The researcher uses a transformative theoretical framework to deal with the needs of a specific population and to seek change (Guest and Fleming 2015).

3.4 Multiphase mixed methods

Multiphase mixed methods research is conducted over a period of time and involves conducting several phases of interconnected quantitative and qualitative research to address a central research problem (Almeida 2018; Morse and Niehaus 2009). It is a sophisticated approach that collects data either sequentially or concurrently and involves the implementation of distinct studies or phases within an overall research project (Guest and Fleming 2015). It allows a research question to be comprehensively explored and answered, and is especially useful for answering complex research questions that require more than one research method to be understood (*ibid*.). Data can be collected using quantitative, qualitative or a combination of both methodologies depending on the specific objectives of each phase of research, and the findings are triangulated meaning that they are more robust than those coming from a single study alone (Morse and Niehaus 2009). In this PhD thesis, the results from both studies were triangulated in the discussion chapter to address the overarching aim of this thesis which was to examine the role of TTNs in supporting people with multimorbidity to engage in regular and sustained self-management of their health and well-being from home using digital health technology.

3.4.1. Strengths and limitations

Creswell and Plano Clark (2007) assert that multiphase mixed methods research provides researchers with deeper and nuanced insights into the phenomenon under study. Further, the authors state that this design is adaptable and allows researchers to modify later phases of research if and when necessary, based on insights gained in earlier ones. Finally, triangulating findings enhances the validity of the findings (Guest and Fleming 2015).

However, it is a resource intensive approach that requires significant time, effort and funding to accomplish (Creswell and Plano Clark 2007). Managing and integrating different methodologies is complex and requires planning to ensure methodological consistency (*ibid*.). Moreover, achieving easily understandable findings may be difficult because of the triangulation process (Morse and Niehaus 2009).

3.4.2 Rationale for choice of research design

The most suitable approach to answer the research question must be determined by the researcher (Doyle et al. 2009), and in choosing their approach, there are three important decisions they must make (Creswell and Plano Clark 2007). These decisions concern: (1) whether or not to conduct the research stages concurrently or sequentially; (2) deciding on which paradigm is given priority or whether neither is given it; and, (3) at what point in the process the mixing of the qualitative and quantitative methods occur (*ibid.*). This study uses a multiphase mixed method design in order to achieve this PhD's aim and objectives.

Study 1 was an exploratory qualitative study which examined the supports provided by the TTNs to a sub-set of multimorbid PwMs participating in the SMILE project who were self-managing their health through the use of DHT. During the course of Study 1, a latent theme that surfaced was that of the support that the TTNs gave the PwMs in relation to their engagement with the DHT. This became the focus of Study 2 which was a mixed methods study. Study 2, Part 1 collected objective engagement data from 64 PwMs who were participating in the SEURO project. Study 2, Part 2 collected objective engagement and qualitative data from a sub-set of the 64 PwMs (n=24) and investigated the differences in engagement patterns between 12 PwMs who had the support of the TTNs and 12 who did not have their support.

Multiphase mixed methods is a robust framework of inquiry to explore the research objectives outlined for this study. Issues surrounding supporting multimorbid older adults to engage with DHT for the self-management of their health are varied, and require a research approach that is able to reach the depth and breadth necessary to elucidate those issues.

3.5 Chapter summary

In this chapter the research approach that was used in this research project – mixed methods research – was explored, followed by a discussion about the philosophical underpinnings of the methodology. Further, the advantages and the limitations of multiphase mixed methods which was the research design used herein were discussed and its choice for its use in this research project was justified. This chapter is followed by Chapter 4 which describes the research methods used in this study.

Chapter 4: Methods

4.0 Introduction

This chapter will discuss the research methods used herein, including recruitment procedures, data collection and data analysis across two studies that were conducted as part of the research programme. The chapter begins with an overview of the ProACT platform, the DHT used by study participants, describing the technologies used by both PwMs and TTNs, to provide context for the two studies.

The overarching design of this study was multiphase mixed methods with data collected over time in three separate but connected phases. Study 1 was exploratory and collected qualitative data that explored how TTNs supported PwMs to self-manage their multimorbidity through the use of the ProACT platform. The participants who were interviewed for Study 1 were a sub-set of people who were participating in a Sláintecare-funded project SMILE (Supporting Multimorbidity self-care through Integration, Learning and e-Health) that was coordinated by Caredoc. SMILE was conducted across three counties in the South-East of Ireland and PwM participants had been referred to the trial by their respective GPs. This project’s aim was to enable people to self-manage their health and well-being from home with the support of a digital platform and nurse-led remote assessment and triage.

The second study of this project was comprised of two parts. In Part 1 objective engagement data were collected from 64 participants who were participating in the SEURO (Scaling EUROpean citizen driven transferable and transformative digital health) Horizon 2020 project trial and were using the ProACT platform. This study was conducted in the East and South-East of Ireland and built on Study 1 by investigating a latent theme that became evident in the course of the study – how TTNs supported the engagement of PwMs with the DHT to self-manage their health. It should be noted that although the SMILE and SEURO studies both took place in the South-East of Ireland, the two participant cohorts were different, however the same TTNs provided the triage service in both studies. Study 2, Part 2 was a mixed methods exploration of the objective engagement data and qualitative data from semi-structured interviews that were conducted with a sub-set of the 64 SEURO participants (n=24). These data were examined to determine the differences in engagement patterns between 12 PwMs who had TTN support to self-manage their conditions and 12 PwMs who did not have this support. The research progression herein is outlined in Figure 5 on page 91. This chapter now proceeds with an overview of the ProACT platform and continues with a more detailed description of the three studies, their methods and ethics procedures.

Study 1: Exploring how TTNs support older adults with multimorbidity to digitally self-manage in the SMILE project

A qualitative exploration of the supports provided by TTNs to PwMs to self-manage their health through the use of DHT. Data were collected by 10 semi-structured interviews with PwMs who were participating in the SMILE project, three TTNs who provided them with support and two HCPs (one GP and one Practice Nurse). Data were analysed using Braun and Clarke's (2022) protocol for analysing qualitative data.

Study 2, Part 1: A Quantitative Examination of Digital Self-Management Engagement Patterns of PwMs with and without TTN Support

Examination of the objective engagement data collected in the ProACT platform from 64 PwMs who were participating in the SEURO project. This study built on the findings from Study 1 and examined a latent theme in Study 1 – how TTNs supported PwMs to engage in the self-management of their health while using DHT.

Study 2, Part 2: Investigating through Mixed Methods the Digital Self-Management Engagement Patterns of PwMs with and without TTN Support

This mixed-methods study investigated the objective engagement data and data from semi-structured interviews that were conducted with a sub-set of the 64 PwMs (n=24) who were participating in the SEURO project. Qualitative data were analysed using Braun and Clarke's (2022) protocol for analysing qualitative data. The data were examined to determine the differences in engagement patterns between 12 PwMs who had TTN support to self-manage their conditions and 12 PwMs who did not have this support.

Figure 5: Research progression in this thesis

4.1 The ProACT platform

The DHT used by the participants in the studies presented in this thesis was the ProACT platform. The first iteration of the ProACT platform was designed and developed as part of the Horizon 2020 funded project ProACT, on which this PhD candidate worked as a research assistant, as discussed in Chapter One. The aim was to develop a single platform to support older adults with two or more of the chronic conditions – diabetes, chronic obstructive pulmonary disease, heart failure and heart disease – to self-manage with support from a care network. The platform was designed and developed through a detailed user-centred design process that involved (1) interviews and focus groups to understand the requirements of PwMs and those who support their care (including informal and formal carers and HCPs), (2) co-design workshops to validate requirements and translate these into a visual application for end users, and (3) usability testing prior to the deployment of the platform in the ProACT project trial (Doyle et al. 2019; Doyle et al. 2018; Doyle et al. 2017; Murphy et al. 2017). A full description of the ProACT platform and its various components has been described in detail in Doyle et al. (2021). This research article also highlights findings in relation to engagement during the ProACT trial, highlighting how PwM participants took between two and three health readings per day using ProACT. The article discussed the potential factors that enhanced engagement with ProACT and self-management during the trial, one of which was clinical oversight and support by TTNs. This formed the basis of this PhD research. The following sub-sections present an overview of the ProACT platform components to provide context for the studies presented in this thesis.

Figure 6 on page 93 outlines the various components of the ProACT platform and how they interact. For the purposes of the studies presented in this PhD thesis, the relevant components are the devices, the PwM CareApp and the Netwell Admin system used by the triage nurses and the PhD candidate to analyse the objective engagement data collected by the PwMs.

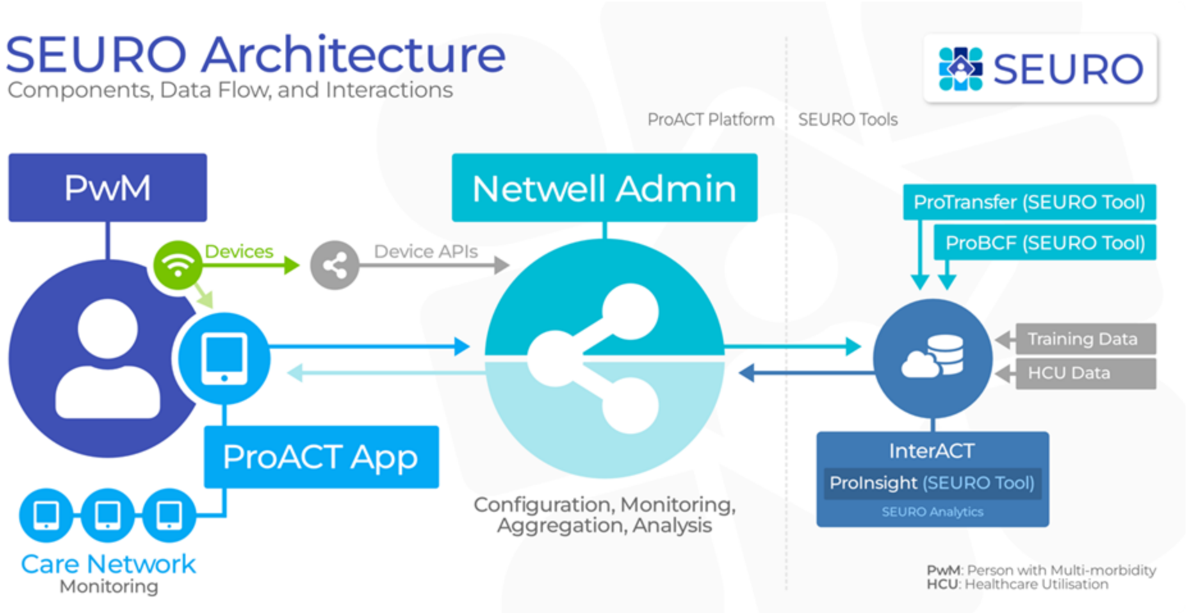


Figure 6: Data flow within the ProACT platform

4.1.1 The devices and CareApp used by PwMs

At the beginning of the SMILE and SEURO programmes, PwMs were given a suite of digital devices for symptom monitoring depending on their conditions (e.g., blood pressure monitor, blood glucose monitor, pulse oximeter) as well as a weighing scales and an activity watch for measuring steps and sleep. An iPad with the ProACT CareApp installed on it was also provided to PwMs. Figures 7 to 9 (pages 94 and 95) show the CareApp that was used by SMILE PwMs. Figure 7 shows the dashboard of the CareApp, which shows the PwM's current status across the health and well-being parameters they monitor. Blue petals on the dashboard indicate that this parameter is within the PwM's personalised threshold (e.g., that their blood pressure is within their normal range) or provide a quick-link to other sections of the CareApp; orange petals indicate that a reading has not been taken for a period of time; while pink petals, which are also slightly larger, indicate that the parameter is outside their normal threshold and require further action. PwMs can also view their symptom readings over time (Figure 8), self-report on their health and well-being, set activity goals and view personalised educational content (Figure 9).

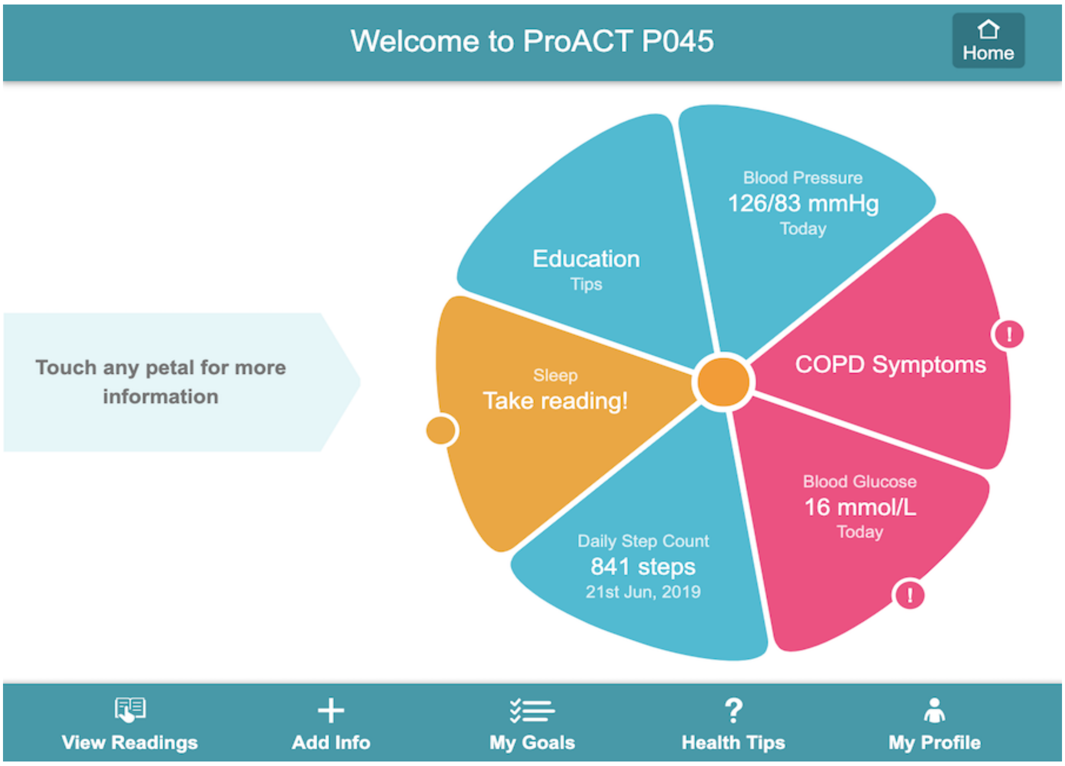


Figure 7: The ProACT CareApp dashboard used by SMILE PwMs showing current status across different conditions

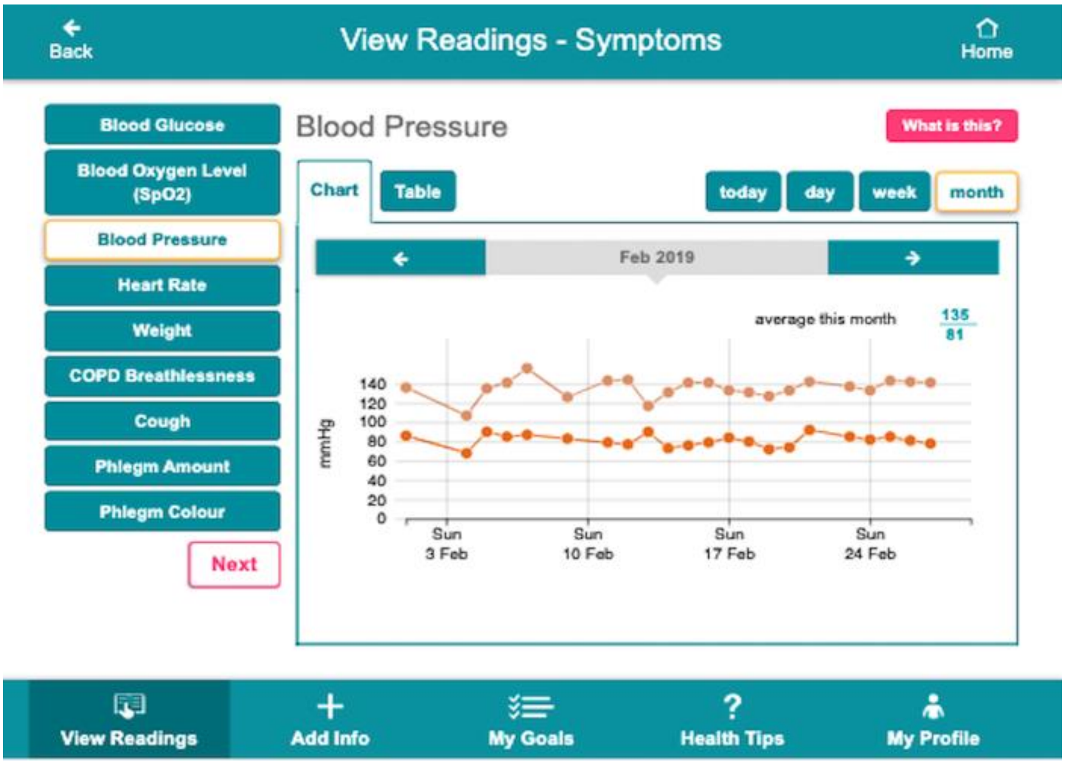


Figure 8: The ProACT CareApp used by SMILE PwMs showing data trends over time for various symptom parameters

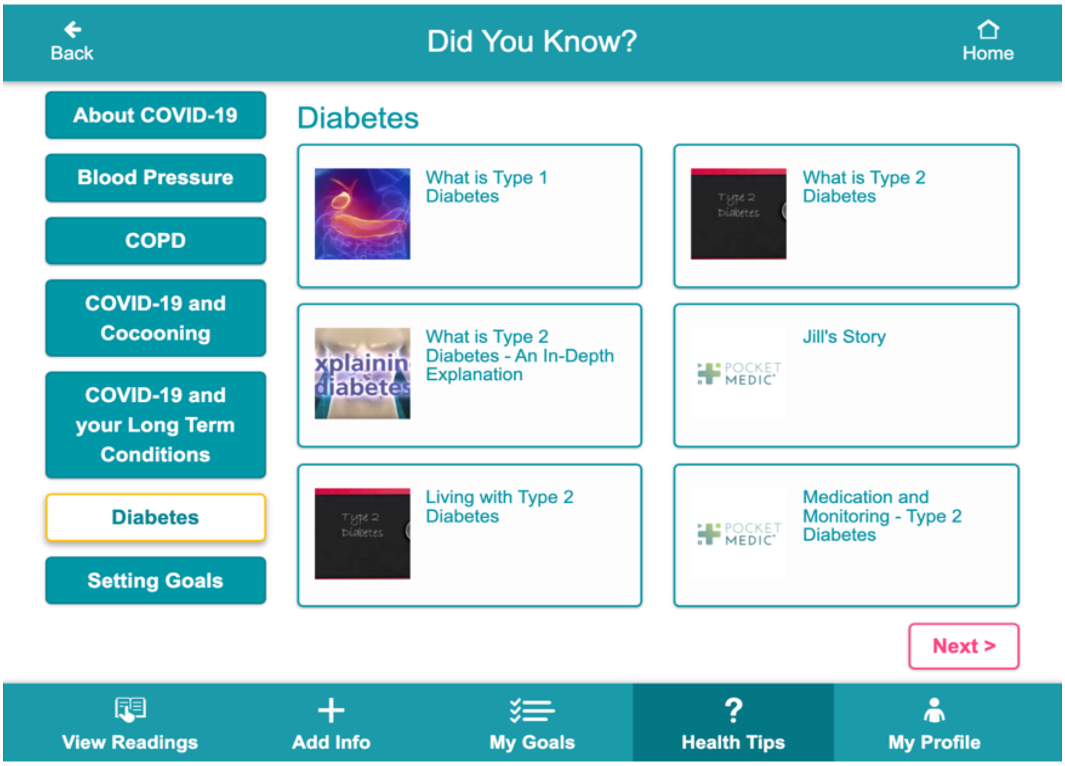
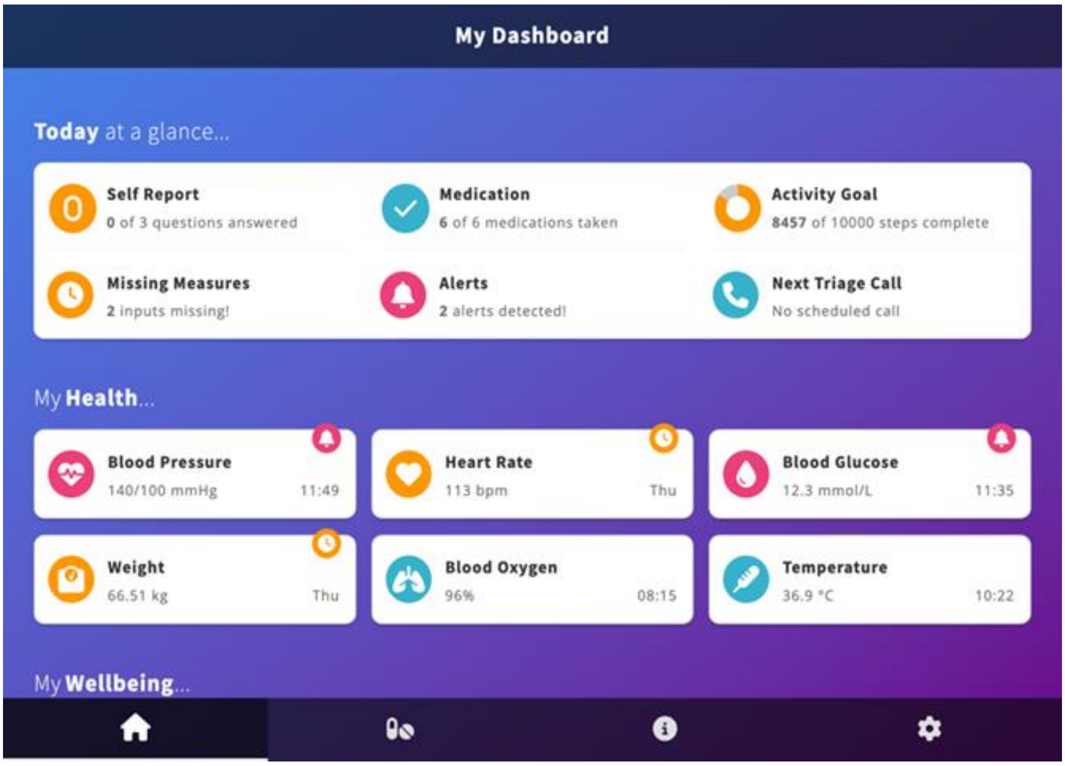


Figure 9: The library of educational content in the CareApp used by SMILE PwMs

Prior to the SEURO trial, the CareApp's design was updated. The purpose of the redesign was to provide a sleeker interface and to simplify navigation for SEURO PwMs. The majority of the functionality remained the same, with the addition of a new medication management feature that supported the PwM in creating and maintaining a digital list and schedule of their medications, and tracking medication adherence. Examples of the updated CareApp can be found in Figures 10 to 12 (below and page 97).



My Dashboard

Today at a glance...

Self Report
0 of 3 questions answered

Medication
6 of 6 medications taken

Activity Goal
8457 of 10000 steps complete

Missing Measures
2 inputs missing!

Alerts
2 alerts detected!

Next Triage Call
No scheduled call

My Health...

Blood Pressure
140/100 mmHg 11:49

Heart Rate
113 bpm Thu

Blood Glucose
12.3 mmol/L 11:35

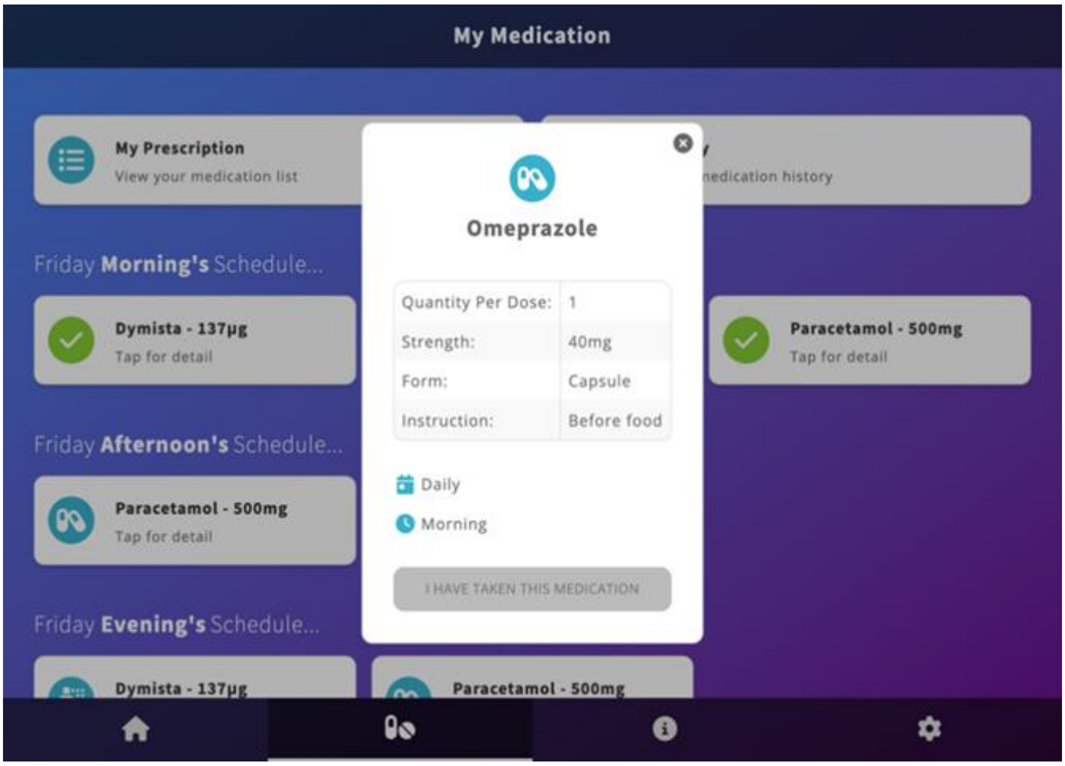
Weight
66.51 kg Thu

Blood Oxygen
96% 08:15

Temperature
36.9 °C 10:22

My Wellbeing...

Figure 10: CareApp dashboard used by SEURO PwMs



Quantity Per Dose: 1
Strength: 40mg
Form: Capsule
Instruction: Before food

Figure 11: Medication screen of the CareApp used by SEURO PwMs

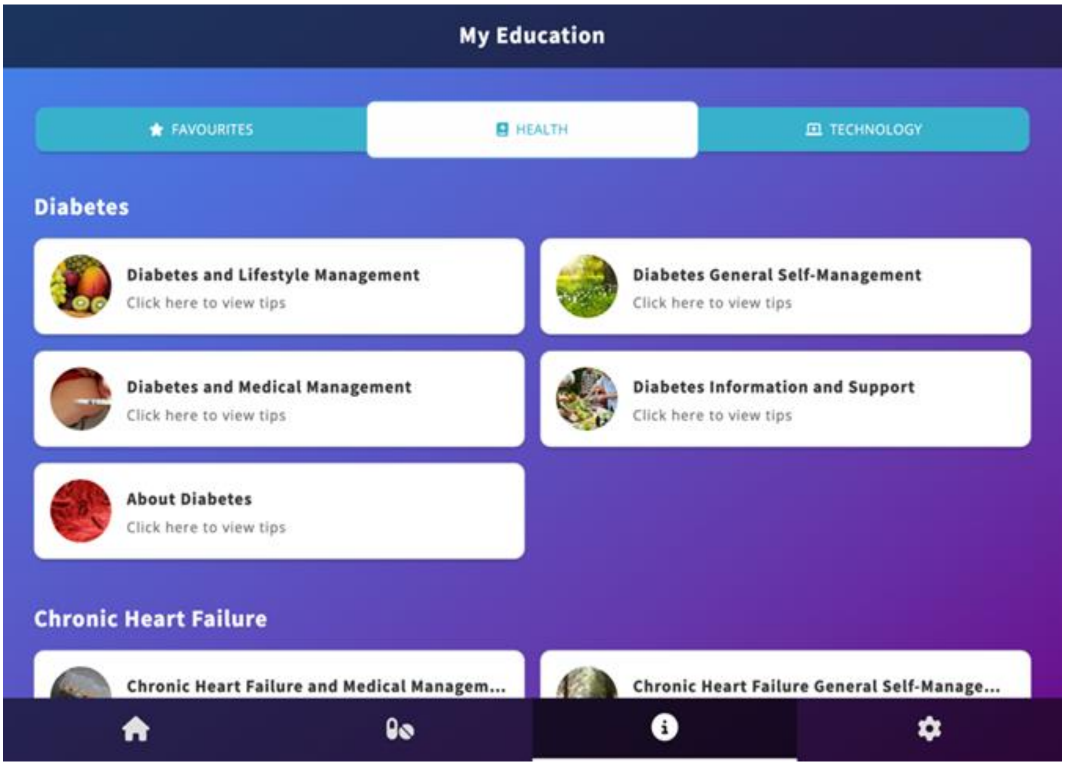


Figure 12: Education library in the CareApp used by SEURO PwMs

4.1.2 The system used by TTNs

The triage system used by the TTNs (Netwell Admin) is a custom-designed application through which the TTNs viewed and responded to alerts generated by data collected from the PwMs in both the SMILE and SEURO trials. At the start of both trials all participants had the same alert parameters (Table 4 below) that were set by the TTNs. Throughout the trials, alert parameters could change for individuals based on their health or on input from their HCP for example.

Table 4: *Device alert parameters*

Parameter	Device Alerts
Blood glucose low	4 mmol/L
Blood glucose high	11 mmol/L
Blood oxygen low	90%
Blood pressure systolic low	100 mmHg
Blood pressure systolic high	150 mmHg
Blood pressure diastolic low	50 mmHg
Blood pressure diastolic high	90 mmHg
Heart rate low	50 bpm
Heart rate high	90 bpm
Short-term weight gain high	2kg

The system's landing page (Figure 13, page 99) shows a listing of all participants in the group, including who has open alerts[1]. When a TTN clicks on an individual PwM, they see some information on the PwM including demographic information, how many open alerts they have and when their next triage call is scheduled (Figure 14, page 100). Monthly check-in calls are typically scheduled with participants, while additional calls deal with alerts as they come into the system. Alerts occur when the thresholds set for different conditions in the system are outside the normal range for the participant. For example, a reading for high blood

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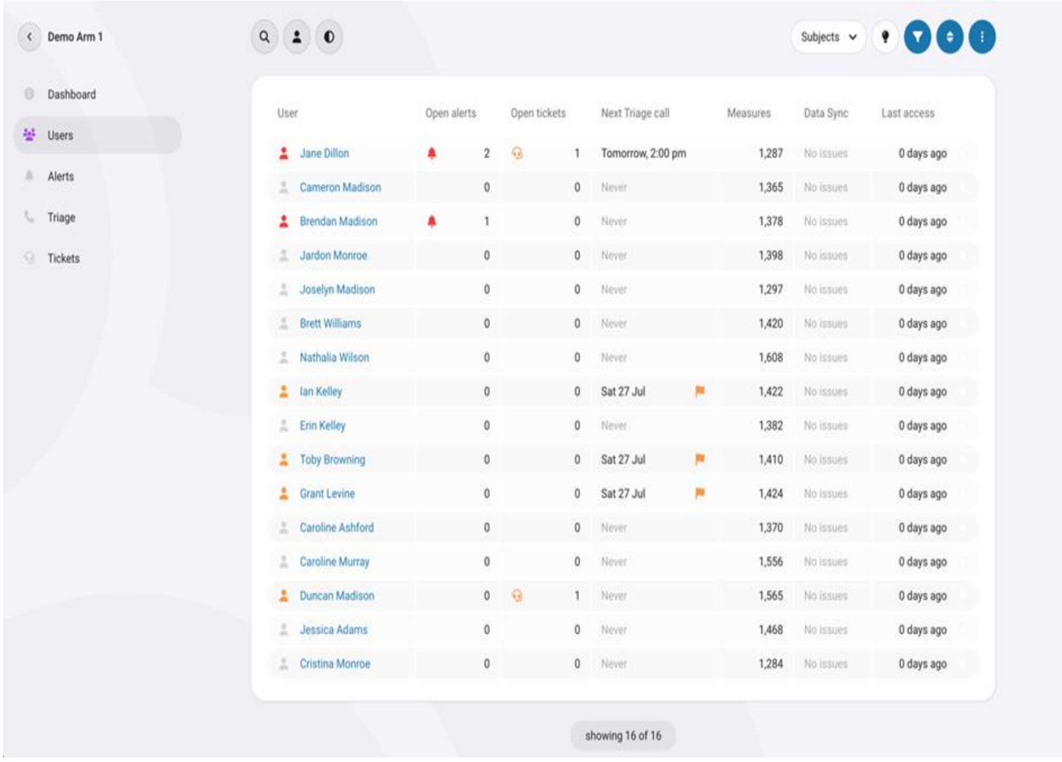
[1] All names shown in screenshots are not those of real PwM participants

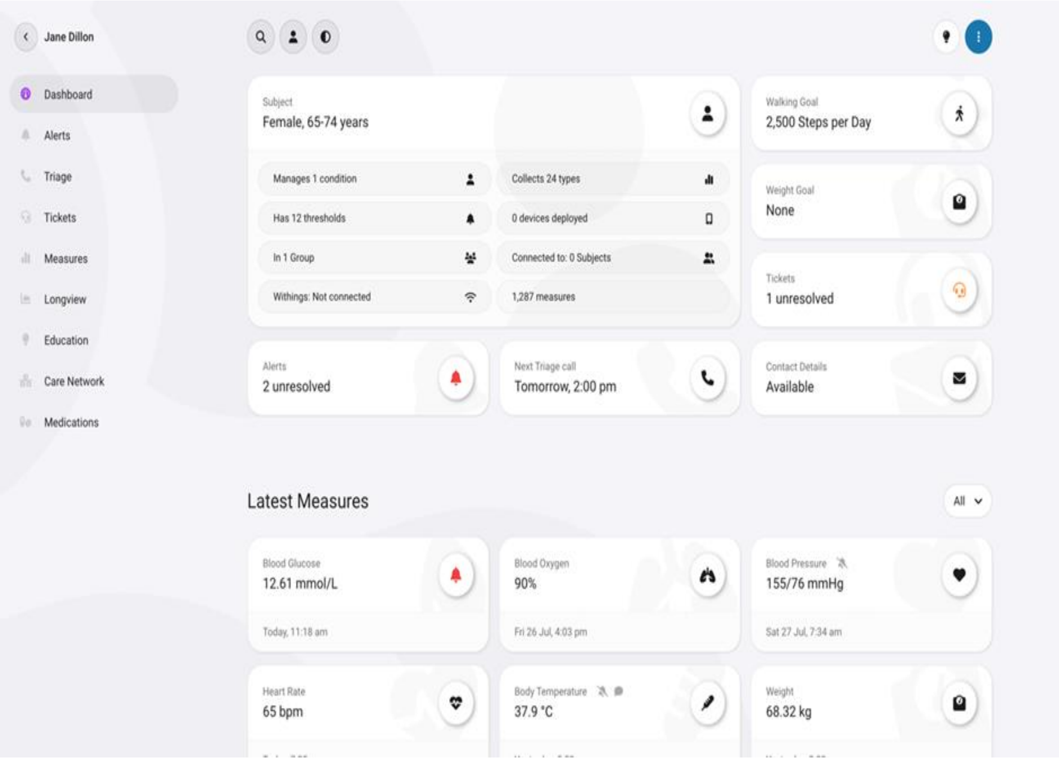
glucose might be anything over 14 mmol/L (but is configurable for each participant). TTNs can inspect individual alerts (Figure 15, page 100) and can resolve these by marking them as addressed (advice provided to PwM, alert resolved) or dismissed/discarded (for example, if the PwM takes further readings that are normal). TTNs can also create notes in relation to alerts, visible by all TTNs on the team. PwMs' health and well-being data are also available, providing the triage team with a holistic picture of the PwMs' health before they call them to discuss an alert (Figure 15).



User	Open alerts	Open tickets	Next Triage call	Measures	Data Sync	Last access
Jane Dillon	2	1	Tomorrow, 2:00 pm	1,287	No issues	0 days ago
Cameron Madison	0	0	Never	1,365	No issues	0 days ago
Brendan Madison	1	0	Never	1,378	No issues	0 days ago
Jardon Monroe	0	0	Never	1,398	No issues	0 days ago
Joselyn Madison	0	0	Never	1,297	No issues	0 days ago
Brett Williams	0	0	Never	1,420	No issues	0 days ago
Nathalia Wilson	0	0	Never	1,608	No issues	0 days ago
Ian Kelley	0	0	Sat 27 Jul	1,422	No issues	0 days ago
Erin Kelley	0	0	Never	1,382	No issues	0 days ago
Toby Browning	0	0	Sat 27 Jul	1,410	No issues	0 days ago
Grant Levine	0	0	Sat 27 Jul	1,424	No issues	0 days ago
Caroline Ashford	0	0	Never	1,370	No issues	0 days ago
Caroline Murray	0	0	Never	1,556	No issues	0 days ago
Duncan Madison	0	1	Never	1,565	No issues	0 days ago
Jessica Adams	0	0	Never	1,468	No issues	0 days ago
Cristina Monroe	0	0	Never	1,284	No issues	0 days ago

showing 16 of 16

Figure 13: Netwell Admin landing page showing list of PwM participants and open alerts (Note: names are not those of real participants)



Subject: Female, 65-74 years

Manages 1 condition
Has 12 thresholds
In 1 Group
Withings: Not connected
Collects 24 types
0 devices deployed
Connected to: 0 Subjects
1,287 measures

Walking Goal: 2,500 Steps per Day

Weight Goal: None

Tickets: 1 unresolved

Alerts: 2 unresolved

Next Triage call: Tomorrow, 2:00 pm

Contact Details: Available

Blood Glucose: 12.61 mmol/L (Today, 11:18 am)

Blood Oxygen: 90% (Fri 26 Jul, 4:03 pm)

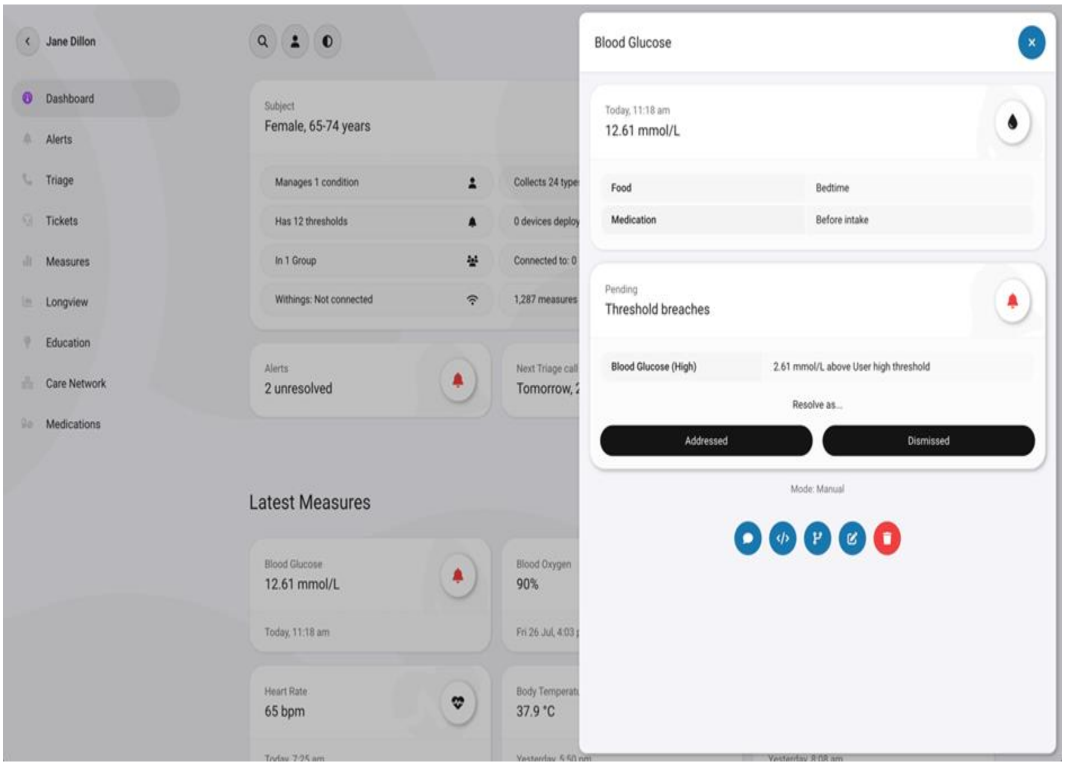
Blood Pressure: 155/76 mmHg (Sat 27 Jul, 7:34 am)

Heart Rate: 65 bpm

Body Temperature: 37.9 °C

Weight: 68.32 kg

Figure 14: Inspecting an individual PwM's information



Today, 11:18 am
12.61 mmol/L

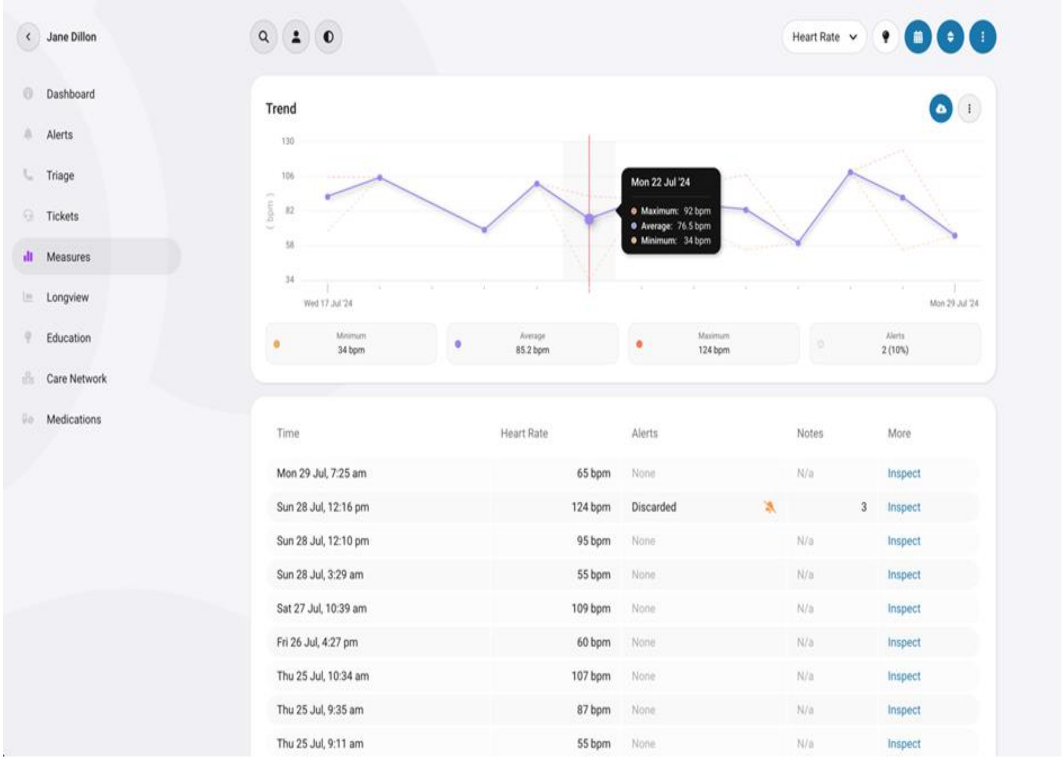
Food: Bedtime
Medication: Before intake

Pending
Threshold breaches

Blood Glucose (High): 2.61 mmol/L above User high threshold

Figure 15: Inspecting an individual PwM's alert

The Netwell Admin system is also used by researchers for data inspection and to support downloading and analysis of data in the platform, including trends of data over time (as can be seen in Figure 16 below and Figure 17, page 102) and engagement with the various devices and features of the CareApp.



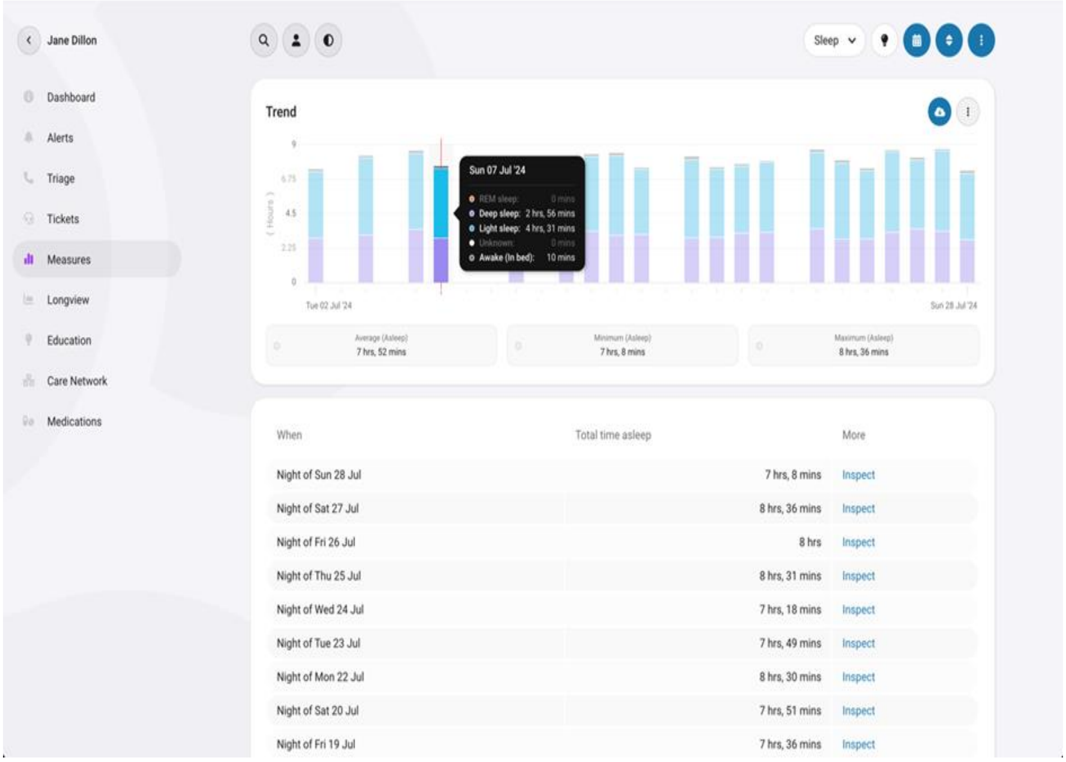
Mon 22 Jul '24
Maximum: 92 bpm
Average: 76.5 bpm
Minimum: 34 bpm

Minimum: 34 bpm
Average: 85.2 bpm
Maximum: 124 bpm
Alerts: 2 (10%)

Time	Heart Rate	Alerts	Notes	More
Mon 29 Jul, 7:25 am	65 bpm	None	N/a	Inspect
Sun 28 Jul, 12:16 pm	124 bpm	Discarded	3	Inspect
Sun 28 Jul, 12:10 pm	95 bpm	None	N/a	Inspect
Sun 28 Jul, 3:29 am	55 bpm	None	N/a	Inspect
Sat 27 Jul, 10:39 am	109 bpm	None	N/a	Inspect
Fri 26 Jul, 4:27 pm	60 bpm	None	N/a	Inspect
Thu 25 Jul, 10:34 am	107 bpm	None	N/a	Inspect
Thu 25 Jul, 9:35 am	87 bpm	None	N/a	Inspect
Thu 25 Jul, 9:11 am	55 bpm	None	N/a	Inspect

Figure 16: Inspecting heart rate trends

The analysis of engagement data available in the platform is outlined further in Section 4.2.3 on page 101.



Sun 07 Jul '24
REM sleep: 0 mins
Deep sleep: 2 hrs, 56 mins
Light sleep: 4 hrs, 31 mins
Unknown: 0 mins
Awake (In bed): 10 mins

Average (Asleep): 7 hrs, 52 mins
Minimum (Asleep): 7 hrs, 8 mins
Maximum (Asleep): 8 hrs, 36 mins

When	Total time asleep	More
Night of Sun 28 Jul	7 hrs, 8 mins	Inspect
Night of Sat 27 Jul	8 hrs, 36 mins	Inspect
Night of Fri 26 Jul	8 hrs	Inspect
Night of Thu 25 Jul	8 hrs, 31 mins	Inspect
Night of Wed 24 Jul	7 hrs, 18 mins	Inspect
Night of Tue 23 Jul	7 hrs, 49 mins	Inspect
Night of Mon 22 Jul	8 hrs, 30 mins	Inspect
Night of Sat 20 Jul	7 hrs, 51 mins	Inspect
Night of Fri 19 Jul	7 hrs, 36 mins	Inspect

Figure 17: Inspecting sleep trends

4.2 Study 1: Exploring how TTNs support older adults with multimorbidity to digitally self-manage in the SMILE project

4.2.1 Participants and sample design

The first study involved recruitment of a sub-set of PwMs who were already participating in the SMILE project and had been using the ProACT platform for approximately eight to 10 months as part of SMILE. The inclusion criteria for participating in this SMILE service are that an individual has one or more chronic conditions and is 18 and over. For this PhD project, the inclusion criteria provided by the candidate were that PwM participants were aged 65 and over, however, four participants were aged under 65. Due to the difficulty in recruiting appropriate participants because of the impact of COVID-19, a pragmatic decision was made to proceed with including in the study the PwMs that Caredoc were able to recruit.

For the purposes of this PhD study, convenience sampling was used to recruit participants. In consultation with the PhD candidate, Caredoc recruited a sub-set of 10 PwMs. At the time when Study 1 was conducted, participants were referred into SMILE through two GP clinics, through the community intervention team at Caredoc or through hospital consultants in the South-East. HCPs were not recruited by Caredoc – SMILE was a service that they referred their patients into. Also, at the time of this study, there were approximately 80 PwMs that were part of SMILE, and it was proposed to run for one year only. Originally, it was intended to recruit 15 PwMs, but because of the pandemic, it became evident that recruiting this number of participants from this population was not possible. Therefore, a pragmatic decision was taken by the PhD candidate to conduct their research with as many participants as was possible to recruit. Baker and Edwards (2012) proposed that optimum sample size decisions prior to commencing a research study is fraught with difficulty, with considerations such as the nature and purpose of the study and practical issues around time and resources needing to be taken into account. In addition, participants had to have two or more of the following conditions: chronic heart disease (CHD); Chronic Obstructive Pulmonary Disease (COPD); type 2 diabetes (T2D); hypertension (HTN); and chronic heart failure (CHF). Three TTNs working for Caredoc who were providing the clinical triage service for SMILE were recruited to participate in this PhD study. The nurses had between 11-and-17 years' experience of working as TTNs at the time of data collection, and also had one year's experience providing triage support to PwMs in the original ProACT Horizon 2020 project that took place between 2018-2019, which meant they were very familiar with the process of remote monitoring before the SMILE and SEURO projects. Monitoring took place seven days per week and was carried out in Caredoc's offices in Carlow.

Further, a General Practitioner (GP) and a Practice Nurse (from the same GP practice) who were referring participants into SMILE were also recruited through Caredoc. It must be noted that the GP and Practice Nurse did not have ongoing access to the participants' data except if the PwM brought their iPad with them on their appointment. All participants were provided with the participant information leaflets which described the research project herein (see Appendix A for example of the PwM participant information leaflet) and completed consent forms (see Appendix B for blank example). The participant information leaflet provided clear and easy to understand information about the study (i.e., its purpose, methods, the benefits and risks of taking part). It also gave the prospective participants an opportunity to contact the PhD candidate with any questions they may have regarding the study. Finally, as per the consent forms for the larger SMILE project, participants were advised that the nurse service was not a replacement for usual care. They were encouraged to go to their GP/HCP if they felt it necessary, or in the case of a participant from the ProACT No Support cohort, if they were concerned about their readings.

4.2.2 Procedures and data collection

As part of the SMILE study, a field technician in Caredoc was responsible for deploying the ProACT technologies to PwMs and providing training and ongoing technical support as needed. All PwMs received a blood pressure monitor that collected both blood pressure and heart rate, a weight scales and a smart watch that collected activity (steps and distance, and sleep). Those with diabetes were provided with a blood glucose monitor while those with a respiratory condition were provided with a pulse oximeter. The devices were personalised to each participant’s condition with personalised triage alerts set by the TTNs as outlined previously in Section 4.1.2. A training manual was provided as well as access to the technical help desk.

PwMs were onboarded onto the study from February 2020 and were asked to engage with the technology as they wished. Participants were recruited from a relatively small geographic area in the South East of Ireland, which would have allowed for home visits if further face-to-face training or technical support was required. However, the onset of COVID-19 in March 2020 and subsequent lockdowns meant that the majority of support was provided over the phone. Qualitative data were collected by the PhD candidate between November 2020 and March 2021 through semi-structured telephone interviews conducted with the 10 PwMs, one focus group conducted on Zoom with the three TTNs, and finally individual telephone interviews with the GP and Practice Nurse.

The PwMs were asked a series of questions that related to the challenges they faced in managing their conditions, their use of ProACT, their relationships with the TTNs, the supports given to them by the TTNs and finally, the impacts (if any) of COVID-19 on their self-management and access to health care (see Appendix C for the research protocol). The focus group with the TTNs covered topics such as their relationships with the PwMs, the supports they provided to them, the advice given, and how they cared for the PwMs during the COVID-19 pandemic (see Appendix D for the research protocol). The HCP interviews asked questions relating to the SMILE programme, the HCPs’ experience of using technology in their practice, the TTN service and finally, the experience of providing care to the PwMs during the COVID-19 pandemic (see Appendix E for the research protocol). The telephone interviews lasted between 10 minutes and one hour, and the focus group took one hour to complete. Although the PwMs were asked the same series of questions, the difference in the length of interview between the shortest and longest was ascribed to the difference in the type of people interviewed.

4.2.3 Data analysis approach

All interviews and the focus group were audio recorded and transcribed verbatim. Four interviews were transcribed by a professional transcription service and the other six were transcribed by the PhD candidate. The data were thematically analysed using Nvivo 12 software and followed Braun and Clarke's (2022) protocol for analysing qualitative data. A thematic analysis coding example is provided in Appendix F.

The approach to data analysis herein was an inductive, reflexive thematic analysis (RTA) one. The inductive approach to RTA is data-driven and is used when a researcher wishes to produce codes that are entirely reflective of the data content and free from any existing theory or conceptual framework (Byrne 2022). Inductive RTA was used as it was considered suitable for analysing the qualitative data generated in Studies 1 and 2 to answer the research question of: '*would older PwMs engage in regular and sustained digital self-management of their health without the support of TTNs?*' Analysing the data using an extant theory or conceptual framework was not deemed suitable as the subject matter of this thesis, because to date this is a novel area of research.

The RTA approach is easily accessible and flexible and it is used to identify, analyse and report on relationships of meaning in a dataset which allows the researcher to engage fully with the data (Braun and Clarke 2012). According to Braun and Clark (2022), for a researcher, reflexivity is the disciplined process of critically reflecting on what they do, and how and why they do it, and the impacts of these factors on their research. The PhD candidate has a background in Intellectual Disability nursing, where advocating for people frequently unable to speak for themselves was central to their practice. This advocacy focus shapes their worldview and informed their analytic lens. For example, the candidate was particularly attuned to participants' expressions of autonomy, reassurance, and relational support, and recognised how this sensitivity might lead to prioritising these issues when developing codes and themes.

To manage this subjectivity and maintain analytic rigour, the candidate engaged in ongoing reflexive practices. These included revisiting transcripts multiple times to challenge early assumptions, and seeking critical feedback from the supervisory team on theme development. RTA ensured that the voices of participants remained central during data analysis, with the candidate continually questioning how their background as a nurse influenced the interpretation of the data and making conscious efforts to ground themes firmly in participants' accounts. This reflexive approach strengthened the credibility and transparency of the findings.

4.2.3.1 Analytic process

After transcription, the 10 interviews and focus group transcripts were compared to the recordings for accuracy, and corrections were made where necessary. In addition, the PhD candidate listened back to transcripts whenever they were unsure of what had been said by the participant. The process of transcription and listening back to recordings allowed the PhD candidate to become familiar with the data (step one of Braun and Clarke's [2022] process of analysis). Listening back to the recordings was particularly necessary for the four interviews that were transcribed by the transcription service. In addition, memos were created relating to reflections on the participants' comments and also about potential codes. In step two, which was a first round of open coding, 117 initial codes were generated from the six interviews transcribed by the PhD candidate. A second round of open coding was carried out on the professionally transcribed interviews in the same manner as the first round of coding and this round generated another 13 codes, bringing the total number of codes to 130.

In step three which was the initial theme generation phase, the 130 codes were firstly collapsed into 16 broad categories, which after a further process of collapsing generated 13 initial themes. The PhD candidate identified themes on a semantic level as they wished to capture the manifest meaning of what was said by the participants rather than look for a deeper meaning in their words. It is participant-driven and results in findings that are more accessible for a wider audience (Braun and Clarke 2022; Braun and Clarke 2012).

Step four involved a review of the themes with a member of the PhD candidate's supervisory team (J.Doy.) and at this stage nine themes remained. Through a further process of discussion between the PhD candidate and J.Doy. (step five), initially six themes were generated but through further investigation and discussion, two themes were deemed to be topics, so they were removed from the dataset. The final four themes were agreed upon and named and these became the themes reported on in Chapter 5 (step six).

4.3 Study 2, Part 1: A quantitative examination of digital self-management engagement patterns of PwMs with and without TTN support

Study 2, Part 1 conducted research with a sub-set of PwMs (n=64) participating in the SEURO trial. No participants of the SEURO trial were taking part, or had previously taken part, in SMILE (Study 1). This trial is an Effectiveness Implementation Hybrid (EIH) trial (Curran et al. 2012), assessing effectiveness of ProACT through a pragmatic randomised control trial and assessing its implementation through a process evaluation. PwM participants (n=240) were recruited onto the SEURO trial by SEURO researchers in NetwellCASALA, Dundalk Institute of Technology and Trinity College Dublin, who are jointly conducting the main trial research, with the first deployments of ProACT to SEURO participants beginning in February 2023. Inclusion criteria for SEURO were that participants had two or more chronic conditions: CHD or cardiovascular disease (CVD); CHF; COPD, HTN; respiratory conditions (Resp.); and, T2D, were 65 or over and capable of giving informed consent.

Once consented, participants were randomised into one of three cohorts – ProACT Plus TTN Support – participants used ProACT and had self-management support provided by the same three TTNs who provided support to the SMILE participants; ProACT No TTN Support participants used ProACT to self-manage their conditions alone, without TTN support; while participants in the third cohort received standard care as usual. In terms of monitoring, it took place Monday to Friday 9am-5pm in Caredoc's offices in Carlow.

As was the case for Study 1, convenience sampling was used to recruit participants. Participants for the present study were recruited from the ProACT Plus TTN Support and ProACT No TTN Support cohorts in the SEURO trial (32 participants in each cohort). This number was decided upon for pragmatic reasons given the impact of COVID-19 which caused delays to the SEURO trial and the need to complete this PhD study. In addition, at the point of recruitment commencing, 64 PwMs in total had completed the trial and had six months-worth of engagement data available for analysis. Given that sample sizes in digital health studies frequently are small due to the cost of conducting such research, the size of this study's sample which is not based on a powered sample, enabled the PhD candidate to obtain the data needed to fulfil the study's aim (Yingling et al. 2019; Nguyen et al. 2017).

4.3.1 Participants and recruitment

Part 1 of Study 2 took place between April and July 2024 and involved the preparation and analysis of SEURO participants' engagement data that were collected from their usage of the devices and CareApp over 26 weeks of participation and which were available within Netwell Admin (see Section 4.1.2). For this study, data from 64 participants who had completed the trial by the end of March 2024 (including all those who participated in Study 2) and whose data had been archived in the system by this date, were used. As in Study 2, Part 2, the participants came from the ProACT plus TTN Support and ProACT No TTN Support cohorts of the trial and presented with the same conditions. The data from weeks 2 to 27 were reported on because week two of the trial was the first full week of data collection for all participants, while week 27 was the final full week of data collection. The data collection process is described in the following section.

4.3.2 Procedures, data collection and analysis

The trial research staff in Dundalk Institute of Technology and Trinity College Dublin were responsible for deploying the ProACT platform to PwMs, providing training and ongoing technical support through means of a help desk which was staffed by the team of researchers. As in Study 1, when ProACT was deployed to participants they were requested to use the CareApp and devices as they wished. PwMs were recruited from a wide geographic area (primarily the eastern seaboard of Ireland and neighbouring counties in the midlands, with a small number in the south and west). Combined with the fact that there were in total 160 SEURO PwMs using the ProACT platform over the course of the trial (all of those in the ProACT Plus TTN Support and ProACT No TTN Support), ongoing technical support was primarily provided over the phone as face-to-face support would have required significant resources that were not available.

All PwMs received a blood pressure monitor that collected both blood pressure and heart rate, a weight scales and a smart watch that collected activity (steps and distance, and sleep). Those with diabetes were provided with a blood glucose monitor while those with a respiratory condition were provided with a pulse oximeter. The devices were personalised to each participant's condition with personalised triage alerts set by the TTNs as outlined previously in Section 4.1.2. A training manual was provided as well as access to the triage help desk. Data were collected from these devices throughout the PwMs' 6-month participation. As PwMs used the various ProACT devices and CareApp throughout the trial, the frequency and patterns of their engagement was logged by Netwell Admin and made available for inspection by researchers in the Netwell Admin interface. Specifically, the data provides a longitudinal view of an individual participant's lifetime platform engagement and usage with the ProACT technologies as well as with the related services (TTN support and technical helpdesk). Each participant's trial usage is normalised into weekly summaries (weeks 1 to n) of their participation. The following data were available within Netwell Admin and were analysed:

- Overall engagement (any engagement with any part of the platform);
- Any engagement with the CareApp;
- Engagement with features of the CareApp including:
    - Vitals – where a PwM can view graphs and tables of trends of the vitals parameters they are measuring (e.g., blood pressure, blood glucose);

    - Activity – view activity data from the smart watch and self-report on other activities such as cycling, gardening); set a goal in relation to activity;
    - Self-report – answer questions in relation to mood, anxiety, and symptoms not measurable by a device such as breathlessness and view the answers to those questions over time;
    - Sleep – view sleep data including time in REM, light and deep sleep, number of wake-ups;
    - Education – view education in relation to conditions and training materials on how to use the ProACT devices and CareApp; and,
    - Medication management – create and manage a digital prescription and schedule, and track adherence to taking medications.
- Engagement with vitals monitoring, including blood pressure, blood glucose, pulse oximetry (SpO2) and weight.

Heart rate data were collected as part of the blood pressure monitor. Therefore, these data were excluded from the vitals engagement as it did not require a separate interaction on the part of the PwM. Engagement data with the smart watch, which includes monitoring of activity and sleep, was also excluded from analysis as interaction with the watch was passive, that is, the user did not have to engage with the device to collect the data as the data synced automatically once in range with the iPad. However, the data collected from the smart watch (including steps) and the number of goals PwMs set and met throughout their trial periods are presented, as this represents engagement in a health behaviour. Various metrics in relation to triage support are recorded for ProACT Plus TTN Support PwMs including the total number of calls, frequency of calls, and whether calls resulted in a referral to a GP, specialist or hospitalisation.

A new inspection tool in Netwell Admin – Longview – (Figure 18, page 114) gives researchers a longitudinal view of an individual participant's lifetime platform engagement and usage. For this tool, each participant's trial usage is normalised into week summaries (weeks 1 to n) in the categories of 'Engagement', 'Vitals', 'Activity', 'Self-report', 'Triage', 'Tickets' and 'Other' (covering sleep patterns and medication management. Figure 18 shows an individual PwM's interactions with the CareApp and its various components over weeks 2 to 27. The first row (blue) shows the number of days in each week that the participant was engaged with the CareApp (any function area), followed by the app's main functional areas (names displayed on the left-hand side) in the rows beneath. Please note that the darker the shade within the coloured squares the higher the level of usage of the particular component. It should also be noted that a PwM could take a reading such as their blood pressure for example, without needing to use the CareApp, as the data from the blood pressure monitor were automatically uploaded to it. This results in the number of readings taken being greater than the number of times the CareApp was used. Data for engagement with taking readings and the CareApp are therefore presented separately in Chapters 6 and 7.

The relevant data were downloaded from Netwell Admin from the 64 PwMs across the ProACT Plus TTN Support and ProACT No TTN Support cohorts. This involved downloading the relevant data as CSVs (a comma-separated value file) for each individual PwM (Figure 19, page 114) and copying that data into Excel spreadsheets where the data were organised to facilitate data analysis (see Appendix K for an example of the spreadsheets).

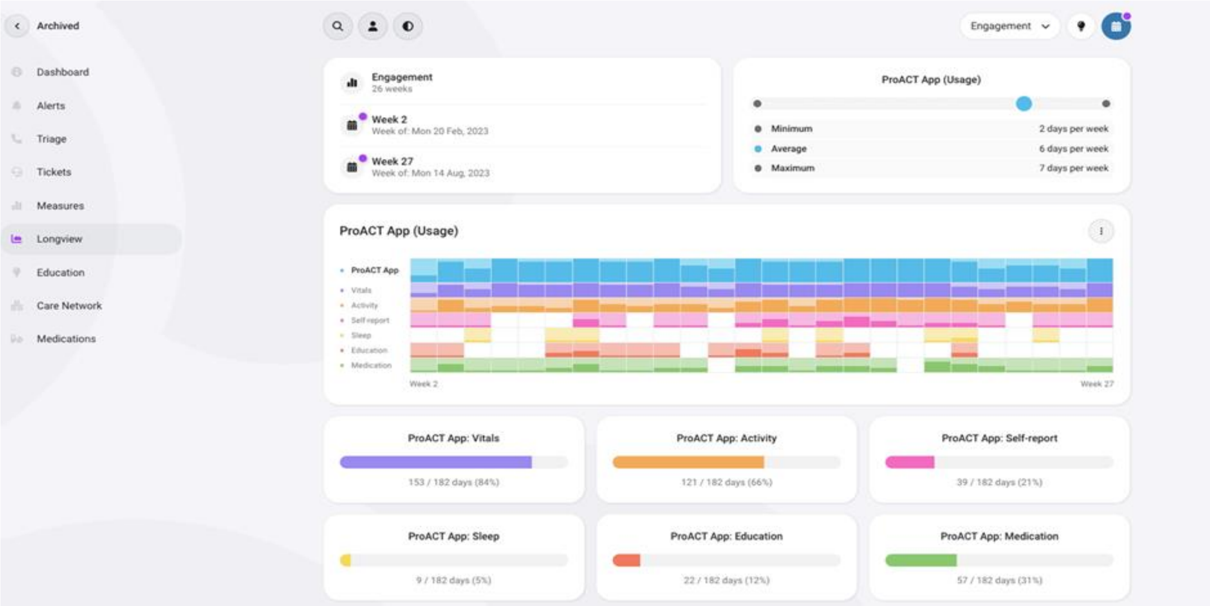
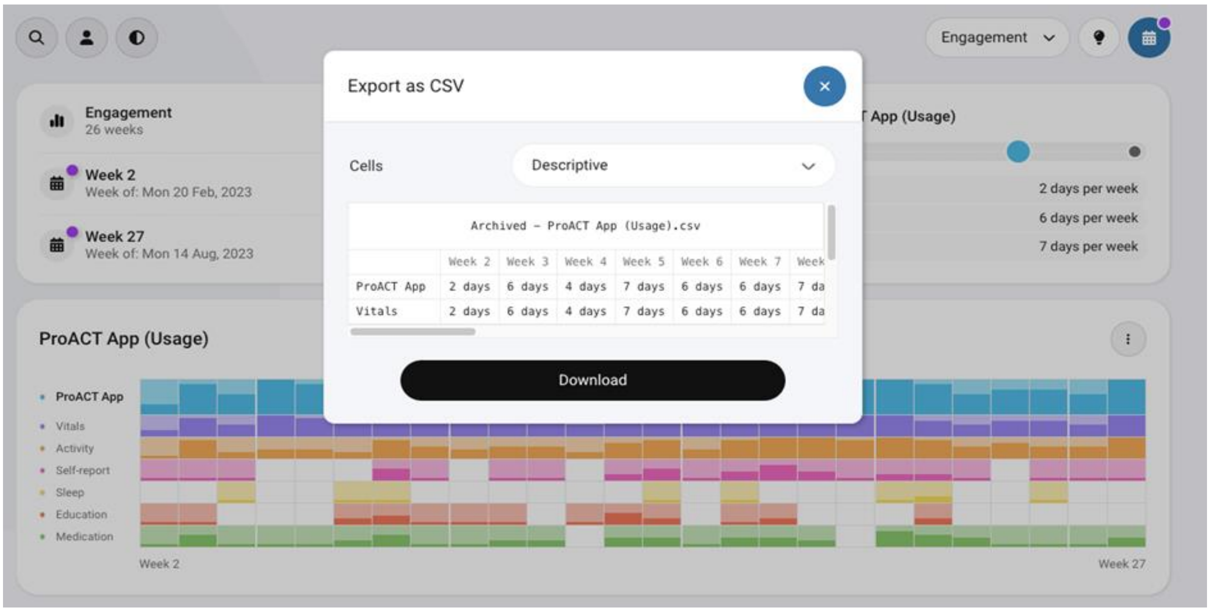


Figure 18: Example of an individual PwMs' CareApp usage as displayed in Netwell Admin



Cells: Descriptive

Archived – ProACT App (Usage).csv

	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week
ProACT App	2 days	6 days	4 days	7 days	6 days	6 days	7 da
Vitals	2 days	6 days	4 days	7 days	6 days	6 days	7 da

Figure 19: PwM's ProACT App (Usage) box showing that clicking on the three dots on the top provides the option to export data as a CSV

Columns were totalled to calculate engagement statistics with the various components of the ProACT platform and differences in engagement between age groups of the PwMs in the ProACT Plus TTN Support and ProACT No TTN Support cohorts. For this purpose, three age groups were selected, namely, 65-74 years, 75-84 years and 85+ years. The spreadsheets were checked for accuracy by J.Doy. and S.G. This analysis is presented in Chapter Seven.

4.4 Study 2, Part 2: Investigating through mixed methods the digital self-management engagement patterns of PwMs with and without TTN support

The qualitative element of this mixed-methods study was conducted between July 2023 and March 2024 with a sub-set of 24 PwMs (n=12 ProACT Plus TTN Support, n=12 ProACT No TTN Support) who had been using the ProACT platform as part of the SEURO project trial for approximately three months by the time of interview. Of the 31 people who met this criterion, 24 consented to participate, a response rate of 77.42%. While it had initially been planned that the participants would be recruited for interviews towards the end of their participation in SEURO (after six months of engagement data), due to delays in the SEURO trial starting, the decision to conduct interviews after three months participation in the project was made. This decision was also made necessary because of the time it would take to conduct the interviews and analyse the data. PwMs were contacted by the PhD candidate to assess their interest in participating in an interview. Those who expressed an interest were provided with participant information leaflets (see Appendix G) similar to those outlined in Section 4.2.1 and consent forms (see Appendix H).

4.4.1 Procedures and data collection

All semi-structured telephone interviews apart from one were conducted by telephone while the remaining interview took place face-to-face as the interviewee had a hearing impairment. ProACT Plus TTN Support participants were asked questions related to their engagement with the DHT, such as how often they took their symptom readings or viewed the readings, the perceived benefits of having their health information, and also their motivation to use the technology. Further, a series of questions enquired about the supports they received from the TTNs and their relationships with them (see Appendix I for the research protocol).

ProACT No TTN Support participants like their ProACT Plus TTN Support counterparts answered the questions about their use of the DHT (see Appendix J for the research protocol). These questions were asked of both trial cohort participants in order to elicit differences (if any) in their engagement with the ProACT platform, and to understand what influenced ProACT No TTN Support participants to use the DHT when they did not have the TTNs' support to self-manage their conditions. The interviews took between 20 minutes and one and a half hours to complete. Data saturation was reached after 10 interviews were completed. However, two additional interviews were carried out in both trial cohorts as participants had already been recruited and had provided their consent to participate.

The objective engagement data for the 24 PwMs were collected from the devices they used during their 6-month participation in the trial, in the same procedure as discussed in Section 4.3.2.

4.4.2 Data analysis

All interviews were audio recorded and transcribed verbatim by the PhD candidate. As in Study 1, the data were thematically analysed using Nvivo 12 software and followed Braun and Clarke's (2022) reflexive protocol for analysing qualitative data (see Appendix F for thematic analysis coding example). The objective engagement data were analysed as discussed in Section 4.3.2.

4.5 Justification for qualitative data collection methods

As mentioned previously, qualitative data collection for Studies 1 and 2, Part 2 were carried out by means of a semi-structured interview conducted over the telephone. During Study 1's data collection phase, government restrictions that were in place because of the COVID-19 pandemic which was happening at the time necessitated the interviews and focus group to be conducted remotely. In Study 2, Part 2 telephone interviews were used due to the wide geographical area that participants came from.

A semi-structured interview was chosen as the qualitative data collection method because it allows the interviewer to ask a range of questions using an interview protocol as a guide to ensure that every question is answered, and encourage interviewees to speak freely (Polit and Beck 2006). Further, using this type of interview in this PhD study meant that any ambiguity that occurred in participants' answers could be clarified, and more in-depth information sought where it was necessary. The interview protocols for both Studies 1 and 2 were reviewed by J.Doy. who has significant experience and expertise in qualitative research in order to mitigate researcher bias.

The second type of data collection method was a focus group which gathers information from a number of people simultaneously, using either a set of questions or a topic guide (Paradis et al. 2016; Polit and Beck 2006). They are an efficient way of gathering a large quantity of different opinions, and are used when the total of a group of people's experiences can offer greater insight into the phenomena of interest than an individual's experiences can (*ibid*). Focus groups let researchers gather similarities and differences in participants' viewpoints, and the reactions of other participants to those perspectives (Paradis et al 2016). The focus group interview protocol was also reviewed by J.Doy., again, to avoid the risk of researcher bias.

4.6 Ethical considerations

Ethical approval for both studies was obtained from the School of Health and Science Research Ethics Committee at Dundalk Institute of Technology prior to data collection. For Study 1, ethical approval was granted in January 2020 (see Appendix L), and for Study 2, Part 2 ethical approval was granted in January 2023 (see Appendix M). Ethics approval for the objective engagement data analysis in Study 2, Part 1 was covered by the ethics approval that was granted for the main SEURO trial.

4.7 Data storage

All research data for both studies were anonymised and were stored on the PhD candidate’s personal laptop which was password protected and only accessible by the researcher. To ensure confidentiality, once Studies 1 and 2’s interviews were recorded, the audio files were immediately transferred to the laptop. Each transcript for both studies was anonymised by assigning a unique identifying number to each participant and the transcripts were also stored on the PhD candidate’s laptop. All audio files were deleted once data analysis was complete. In addition, demographic information for Studies 1 and 2 participants was stored in password-protected Microsoft Excel spreadsheets, the passwords for which were known only to the PhD candidate. The Excel spreadsheets containing the objective engagement data in Study 2, Part 1 were also password-protected and stored on the PhD candidate’s laptop.

4.8 Challenges faced during the course of this PhD

The challenges faced during the completion of this PhD were caused by COVID-19 which impacted this candidate both professionally and personally. From a professional perspective, Study 1 was conducted while the country was under restrictions which meant that data collection with the PwMs had to be done remotely by using telephone interviews. This method of data collection is frequently viewed negatively as a means of collecting qualitative data. This is due to the absence of visual clues which may result in the loss of contextual and nonverbal data, the building of rapport between interviewer and interviewee being impeded and finally, probing and interpretation of responses being compromised (Novick 2008). In addition, because the start of the SEURO project was significantly delayed by the pandemic, this resulted in the recruitment of PwMs to Study 2 being delayed.

On a personal level, COVID-19 impacted on this candidate academically and socially because of having to work from home throughout the lockdowns and restrictions. This resulted in a loss of face-to-face contact from supervisors, and lost opportunities for in-person conference attendance and training programmes. In addition, from a social perspective, the peer support they had from fellow students and contact with work colleagues was removed for a prolonged period of time.

4.9 Chapter summary

In this chapter, the research methods used herein were discussed. These included recruitment procedures, and data collection and data analysis procedures across the three studies that were undertaken for the research programme. In addition, the ProACT platform and DHT used by both the PwMs and TTNs was described in detail. This thesis now continues with the findings from Study 1.

Chapter 5: Study 1 – Exploring how TTNs Support Older Adults with Multimorbidity to Digitally Self-Manage in the SMILE Project

5.0 Introduction

Chapter 5 presents Study 1's findings from the semi-structured interviews that were conducted with the sample that was described in Chapter Four, Section 4.2.1. This is an exploratory phase of the larger second study and its aim is to explore the supports that TTNs provide to older PwMs that enable them to self-manage their health conditions through the use of the ProACT platform.

This chapter begins with the presentation of the demographic data and continues with presenting the findings from the data in which four main themes and associated sub-themes were identified. These are outlined in Table 6 on page 123. The findings are presented in turn in the following sections. As this study was conducted against the background of COVID-19, where it is appropriate, its possible impact upon the PwMs will be discussed. In addition, the viewpoints of the HCP participants will be presented throughout.

5.1 Demographics

10 PwMs participated, of whom 6 (60%) were male and 4 (40%) were female. The HCP participants comprised three female TTNs, one female Practice Nurse and one male GP. See Table 5 on page 122 for a summary of PwM participant demographics. For identification purposes, at the end of PwM participant quotes respondents are identified thus: (ID, gender, age and inclusion conditions). The HCPs are identified by their role (i.e., TTN, PN, GP). While as noted in Chapter 4, Section 4.2.1, Caredoc had been requested to recruit people aged 65 and over, the cohort they recruited included three people aged 50+ years. As recruitment of participants was made particularly difficult because of COVID-19, it was decided to include their data in the dataset herein.

Table 5: *Demographic information Study 1 PwM participants (n=10)*

Age Range ***Mean***	54-86 Years 66.70 Years
Gender *N* (%):	
Male	6 (60.00)
Female	4 (40.00)
Living Status *N* (%):	
Lives Alone	2 (20.00)
Lives with Others	8 (80.00)
Marital Status N (%):	
Married	8 (80.00)
Living with Partner	0 (0.00)
Widowed	2 (20.00)
Single (Never Married)	0 (0.00)
Separated	0 (0.00)
Divorced	0 (0.00)
Condition Profile *N* (%):	
CHD + COPD	2 (20.00)
CHD + HTN	1 (10.00)
CHD+T2D	1 (10.00)
COPD + HTN	1 (10.00)
COPD + T2D	1 (10.00)
HTN + T2D	3 (30.00)
CHD + COPD + T2D	1 (10.00)

Table 6: *Themes and sub-themes for Study 1*

Theme No.	Section No.	Main Themes	Sub-themes	Sub-section No.
1.	5.2	The challenges and impact of multimorbidity	1. Challenges in the self-management of conditions 2. HCPs' perspectives on the challenges PwMs face in self-managing their health 3. The impact of COVID-19 on self-management	5.2.1 5.2.2 5.2.3
2.	5.3	Engagement in self-management of conditions	1. Routines involved in self-management 2. The role of the TTNs in supporting self-management 3. Motivation to engage in and sustain self-management 4. The barriers to engagement in self-management during the trial 5. Perceptions of ProACT for self-management	5.3.1 5.3.2 5.3.3 5.3.4 5.3.5
3.	5.4	The relationship between the PwMs and TTNs	1. The nature of the relationship 2. The quality of the relationship 3. The important aspects of the relationship	5.4.1 5.4.2 5.4.3
4.	5.5	The perceived benefits and outcomes of the SMILE programme	1. Improvements in health and well-being 2. Empowerment to self-manage (i) Increased awareness, knowledge and confidence (ii) Increased peace of mind (iii) More timely interventions and more appropriate health care utilisation	5.5.1 5.5.2 5.5.2.1 5.5.2.2 5.5.2.3

5.2 Theme one – the challenges and impact of multimorbidity

Theme one explores the challenges and impact of multimorbidity, not only from the viewpoint of the PwM, but also from the HCPs' perspectives. In addition, the impact of COVID-19 on the PwMs' self-management is briefly discussed.

5.2.1 Challenges in the self-management of conditions

Whilst managing multimorbidity is burdensome, both physically and mentally, the SMILE PwMs appeared to have been dealing well with the challenges multimorbidity presented them with. For example: *"I didn't have that much really [challenges] because my diabetes thank God is not too bad and I just would be checking it each day…I have to keep a* *book and check it each day*" (SMP02, M, 76, COPD + T2D). "*It was just the blood pressure was the main issue*" (SMP06, F, 54, COPD + T2D).

Nonetheless, physical issues such as difficulty with walking were reported: "*Well, walking and that, I found that very hard*" (SMP01, F, 78, CHD + COPD), experiencing fatigue, unable to take exercise: "*Because my lungs weren't good for a good number of years I didn't have, I didn't have a healthy exercise regime*" and "*I was a great walker and loved it…the difficulty with my lungs restrict me*" (SMP04, M, 69, COPD + HTN), and suffering with pain. The difficulty of trying to recover from prolonged infection and having to take large amounts of medication were also mentioned:

> *I was diagnosed in 2015 with emphysema and I had a lot of, a lot of infection, a lot of challenge, over the years up to now with infection. And at one stage within 14 months, I had 24 10-day cases of steroids and antibiotics to try and shift, I just couldn't get rid of the infection* (SMP04, M, 69, COPD + HTN)

SMP03 (F, 86, CHD + COPD) also spoke of having a prolonged infection: "*Eh well with my condition I got a bad chest infection in February, it took me a month. I've been on steroids and antibiotics and I always have to have two lots of antibiotics and steroids*" (SMP03, F, 86, CHD + COPD). While multimorbidity also places a heavy burden mentally on those living with it, SMP04 (M, 69, COPD + HTN) was the only participant who spoke of having potentially experienced mental health related issues: "*I live on my own you know. Like the thing that rendered all the infection was living on your own and old mood swings and all of that old craic can be, can be part of it like*" (SMP04, M, 69, COPD + HTN).

A knock-on effect of dealing with their health issues was frequent GP visits as experienced by SMP06 (F, 54, COPD + T2D): "*I was going to the doctor more regularly maybe once or twice a month to get the blood pressure checked because it was very high*" (SMP06, F, 54, COPD + T2D). SMP01 (F, 78, CHD + COPD) also experienced this: "*Well I was visiting my GP a lot more. Probably, eh, maybe for breathing problems and things like that*" (SMP01, F, 78, CHD + COPD). Other problems the PwMs spoke about were either confusion surrounding their conditions or having undiagnosed conditions: "*And a lot of things I was putting down to the diabetes I think sometimes could have been attributed to the high blood pressure. Some of the dizziness and some of the different things, you know, I was putting down to maybe the diabetes*" (SMP09, M, 54, HTN + T2D). "*Well, I didn't know really I was diabetic until there about two years ago and I was eating a lot of bars of chocolate a day, bars and sweets and all this you know. And I didn't know I was diabetic until that time*" (SMP05, M, 61, CHD + T2D). This was also an issue for SMP08 (F, 65, CHD + HTN) who spoke of undiagnosed blood pressure: "*I had no idea I had blood pressure anyway until they just did it that particular day and it really got very, very high, you know. And like only for I had this [the SMILE project], I would never have known, you know*" (SMP08, F, 65, CHD + HTN). Participating in the SMILE project meant that SMP05 (M, 61, CHD + T2D) who had a serious heart condition received appropriate treatment through the intervention of the TTNs. SMP05 reported that he had been sent home from hospital four times being told there was nothing wrong with him, despite feeling unwell. Yet, it was the TTNs who alerted him to the fact that he needed to go to hospital as he had a serious heart condition that needed immediate attention:

> *I was after being in hospital four times. They said there was nothing wrong with me. The girl from the SMILE project contacted me and she says "SMP05, your heart is leaping all over your chest". She says "will you go to your nearest hospital? So, I went to the hospital there before the bank holiday weekend, my heart was 90% blocked*
> (SMP05, M, 61, CHD + T2D)

5.2.2 HCPs' perspectives on the challenges PwMs face in self-managing their health

From the GP's perspective, multimorbidity placed a burden on his patients with regards to the various hospitals or clinics they need to attend: "*I suppose the main challenges are that with multimorbidity, sometimes it might mean access to different hospitals, clinics*".

He also noted that this can be made more difficult if they are dealing with mobility problems or a lack of independence: "*So, and sometimes, PwMs get decreased range of functions and sometimes it's very difficult for them you know, to attend a lot of clinics. Sometimes they may be independent or they may be dependent on other people to bring them to clinics*" (GP).

The Practice Nurse was aware that the GP practice was busy and that she did not have enough time to spend with PwMs. She felt concerned that they left the practice not fully understanding the information they were given and then needed to be constantly reassured as a consequence:

> *Then you don't know whether they understand when they go out from us. I think that was a big thing that they didn't grasp what we were saying or there was too much information to take in all at once. Then they needed to be reassured again and again* (PN)

The TTNs spoke about some PwMs' lack of knowledge of their conditions prior to the SMILE programme which had resulted in them not taking their medications because they did not understand the consequences of doing so:

> *I suppose, maybe the full knowledge of what, the knowledge that they had of their own conditions. There would have been a few people in the early days who were very uncompliant. We had one gentleman, a type 2 diabetic just didn't take his medication and didn't understand the consequences for himself and was running sugars up in the twenties the whole time. He's now taking his medication daily* (TTN01)

The TTNs also discussed the fact that PwMs thought for example, that having the flu vaccine was unnecessary, not realising the benefits it provided them with. Further, the TTNs mentioned that there was a lack of recognition in some PwMs of when their symptoms worsened which led to them becoming very ill and requiring hospitalisation.

5.2.3 The impact of COVID-19 on self-management

When asked about the impact of COVID-19 on the self-management of their conditions, only four of the participants reported that it had made a difference. This was in terms of being able to access their HCPs – either their GP or consultant, rather than on their own self-management of their health. For instance, SMP03 (F, 86, CHD + COPD) mentioned that it was very hard to get to see her GP and that a hospital appointment had been cancelled: "*I had an appointment last Wednesday for the stroke clinic but they phoned me the Friday before and said it was cancelled because there was so much COVID in the hospital*" (SMP03, F, 86, CHD + COPD). Further, SMP04 (M, 69, COPD + HTN) reported that he had not seen his GP throughout the course of the year: "*It did as far as the GP was concerned because I haven't sat face-to-face with my GP any time this year*" (SMP04, M, 69, COPD + HTN). However, SMP08 (F, 65, CHD + HTN) stated that although she was not seeing her GP as frequently, she was able to talk to the TTNs instead, which appeared to be a choice she made: "*I found that the nurses, you know, are there online if I want to talk to them. I find I don't contact the doctor as much as I would have, you know, before this*" (SMP08, F, 65, CHD + HTN). Conversely, the other PwMs who felt no impact from COVID-19, were either able to access their HCPs, were happy to be dealt with over the phone as in SMP02's (M, 76, COPD + T2D) case: "*Only last week I did have to ring the GP and they gave me what I needed, a prescription over the phone*" (SMP02, M, 76, COPD + T2D), or felt confident that if they needed to see a GP they would be able to get an appointment: "*No, because if I was needing a doctor I'd be first on the list. He'd try his best; you know he'd never say come back or call back. He'd tell the secretary: 'if SMP05 is out there I'll see him', you know*" (SMP05, M, 61, CHD + T2D).

5.3 Theme two – engagement in self-management of conditions

The second theme examines how the PwMs engaged in the self-management of their conditions. Sub-themes that were identified in the data included: (i) routines involved in self-management; (ii) the role of the TTNs in supporting self-management; (iii) motivation to engage in and sustain self-management; (iv) the barriers to engagement in self-management during the trial; and (v) PwMs' perceptions of ProACT for self-management.

5.3.1 Routines involved in self-management

The PwMs' were asked about any changes they had made to their self-management since beginning the SMILE programme. Several spoke about getting into a daily routine of taking readings, such as their blood pressure and blood glucose, taking their medications and answering the daily questions. This was something that they would not miss doing and for SMP10 (M, 65, HTN + T2D) he believed that having ProACT made him self-manage his blood pressure rather than relying on his GP to do it for him:

> *…that's what gets you to do the self-management because without it, you would just think 'when I go to the doctor he'll check it out', it could be six months or a year. Particularly when I wake up, it's get that computer out and do the readings*
> (SMP10, M, 65, HTN + T2D)

Another participant, SMP05 (M, 61, CHD + T2D), related how he changed the way he was taking his blood pressure readings since commencing the programme, which was on foot of advice from the TTNs:

> *I take it [the blood pressure] in the morning when I come back from the walk. An hour or two after I'm sitting down like. Like, I used to do it the wrong way around. I used to do when I came back first. The heart would be leaping out of my chest, you know. So, like I used to wonder and I used to say to one of the girls, nurses 'to tell you the truth, I'm only after coming back from a walk'. She'd say 'sure leave it for an hour or two you know in the morning'. It would settle down then, it was just reading right* (SMP05, M, 61, CHD + T2D)

Other participants told of how they incorporated walking into their daily routine which was important to them, although one, (SMP04, M, 69, COPD + HTN), felt that he was actually overdoing it by walking 20kms a day during the COVID-19 pandemic in light of his health and age: "*24,000 steps and it was wonderful in one way but for my particular situation it was off the wall because and I'm not hung up, but I'll be 70 years of age next March*" (SMP04, M, 69, COPD + HTN).

5.3.2 The role of the TTNs in supporting self-management

In this sub-theme the PwMs spoke about the practical supports provided to them by the TTNs, which helped them with the self-management of their conditions. The TTNs also spoke about their role in providing the support. Support received included getting advice and educational tips about their medications or health conditions or about when to contact their GP, and also emotional support. Some PwMs reported not only feeling reassured by being able to check their readings but also having the TTNs monitor them.

The PwMs were asked if they always followed the advice given and the majority said they did for reasons such as the TTNs being professional, having expertise, having knowledge and also because they believed that the advice worked for them: "*The advice they gave me, when I followed it, nine times out of 10, it would be sorted and sometimes it would be just maybe I'd have to get the medication tweaked another bit, but it would have been sorted on their advice*" (SMP09, M, 54, HTN + T2D). Several PwMs said that they would be foolish if they ignored the advice, however one PwM reported that she had ignored the advice given about contacting her GP and consequently regretted that decision: "*You know, like when they say to me 'oh well go to the doctor and get this and do this' and I think 'oh well, I won't bother'* *and then a couple of days later I think that I should have done it when they said it to me*" (SMP03, F, 86, CHD + COPD).

The TTNs spoke about the approach they took in giving support to the PwMs. They talked about tailoring the advice they gave, according to the person they were dealing with and not taking a 'one size fits all approach'. Using previous conversations held with the PwMs, knowing about their backgrounds, understanding their environmental impacts, looking at the ProACT data over time and observing trends were all important in helping them to make accurate assessments of the PwMs' needs. They also spoke about keeping the advice simple so that the PwMs understood it and took it on board: "*It's very gradually bringing it absolutely down to a level of education that you know that they'll understand and take it on board. If you give them too much too quickly, they'll do nothing. It's like baby steps*" (TTN03).

The TTNs were asked whether the PwMs always followed their advice. The majority did because they were invested in improving their health and so were willing to take the advice on board. Humour, encouragement and not 'telling the PwM off' were strategies used by the TTNs to prevent the participants from ignoring the advice. In cases where the advice was not taken, the TTNs persisted until the advice was listened to: "*But like I mean as I say we're like a stone in the shoe. We keep ringing you know. There's a lot of very gentle cajoling and you know, and then when they do it, and they do it well, we're full of praise, you know what I mean"* (TTN03).

When asked whether COVID-19 had changed the supports they were giving the PwMs, the TTNs responded that they were giving much more emotional support and reassurance than they had prior to the pandemic, as they found the PwMs to be very fearful and anxious: "*Allaying fears isn't it again? It comes back to fear of the unknown, how much was unknown for us all really. The news was always harping on about chronic conditions and chronic* *conditions. You know that was a difficult thing*" (TTN02). The PwMs were also experiencing loneliness and depression because of not being able to see their families, but even after the lockdowns were lifted, they were isolating themselves from family members through fear of contracting COVID-19. The TTNs' advice also changed to advising the PwMs how to keep safe during the pandemic by wearing face masks, proper handwashing and telephoning rather than visiting their GPs: "*It was just talking them through good practice, letting them open up again and trying to learn to live with it rather than live in fear all the time, keeping safe at the same time*" (TTN01).

5.3.3 Motivation to engage in and sustain self-management

There were several factors which influenced the PwMs' motivation to engage in their self-management. One person (SMP02, M, 76, COPD + T2D) mentioned his heart condition as the reason he kept engaging with his self-management: "*Well I have pretty good old motivation really you know, because I had a lot of problems with my heart along the way*" (SMP02, M, 76, COPD + T2D). However, the most frequently mentioned factor by PwMs, discussed by eight of them, was knowing that the TTNs were monitoring them (mentioned by seven participants), which they believed was a positive thing as it incentivised them to take readings, for example:

> *Well again, it's just the thing of the awareness that if you got a phone call to say your old blood pressure is up, you'd have a look and maybe I would, a couple of times, quite a few times I would have stuck on the old monitor…it gave you the old incentive just to keep a better eye to your old own set up and your own old readings*
> (SEP04, M, 69, COPD + HTN)

In fact, some PwMs perceived that they would not be able to continue using ProACT without the support of the TTNs who were able to help them understand why a reading was high, for example. Further, PwMs felt that knowing the TTNs were looking at their readings and would ring them if a blood pressure reading was high for instance, was motivation for them to take action to avoid it recurring. This would have been by keeping a better watch on their own readings, changing when they were taking them (for example, waiting for a period of time after exercising when their pulse would have returned to normal), or taking a walk. The PwMs also felt a sense of loyalty to the TTNs, feeling that if they were concerned enough to ring them then they should also engage: "*Well, like when they're going to the bother of ringing me and keeping an eye out, well I have to play my part as well*" (SMP01, F, 78, CHD + COPD). Two PwMs mentioned that without being monitored they would not be inclined to take exercise. For others, knowing that they were going to receive a phone call if they did not take their readings was an incentive to do so. The Practice Nurse also spoke about the TTNs being an incentive for the PwMs' engagement behaviours, acknowledging that having somebody keeping a closer watch on them than she was able to was good motivation: "*I think having somebody on your skids more often than we are definitely makes you think about all that. 'She's going to be ringing me, I want to be able to say I have it done'*" (PN).

Six PwMs also revealed that seeing the readings and changing their health behaviours when appropriate kept them motivated to continue self-management because they could see the positive impact on their health: "*Like when you have a kind of monitor there showing you and telling you like, you do try that little bit harder*" (SMP07, M, 59, HTN + T2D). The TTNs also acknowledged this, stating that PwMs responded to readings outside their normal range because they knew that the TTNs would contact them, hence, it motivated them to keep on with their self-management.

Some of the participants spoke about the reasons they kept self-managing their health, which they attributed to feeling they should take responsibility for managing their own health and to the influence of the TTNs. Participant SMP04 (M, 69, COPD + HTN) acknowledged that his COPD had made him realise that he needed to take exercise and look after himself: “*I’ve learnt that my old lungs are my responsibility… the buck stops with me*” (SMP04, M, 69, COPD + HTN). Further, SMP03 (F, 86, CHD + COPD) spoke about needing to help herself and re-engage with her self-management after being reluctant to do so after a stay in hospital: “*I just thought ‘no I can’t do that, no’. But then I pulled myself together and started back on it*” (SMP03, F, 86, CHD + COPD). The PwMs’ belief that they were responsible for their own health was echoed by the GP who stressed the importance of patients ‘buying in’ to their illness self-management in order to improve their health and well-being. He referred to the fact that he sometimes felt that his patients believed their ill health was his problem rather than their own, and that their getting involved improved things for everybody. The Practice Nurse felt that the technology gave the PwMs encouragement to sustain their self-management, and reassurance from seeing their readings. The TTNs also reported this, and they also felt that having the readings and seeing the trends over time acted as a motivator to make improvements in their health management: “*So if they can see too you know, the data…‘look if I do this, this is going to be improved’ and again it’s about education and encouragement. If they can see the trends themselves which is huge*” (TTN03).

A sense of responsibility to the TTNs was acknowledged by SMP10 (M, 65, HTN+T2D) who stated that he did not want to let them down as a reason for engaging with his self-management:

> *That’s another reason you carry on because you sort of don’t want to let them [the TTNs} down. Sometimes you really feel enough is enough and I don’t feel like sleeping with this watch all night. I never used to wear a watch unless I went running, like a sports watch And you think ‘I’ve had enough of this’, having this on your arm* (SMP10, M, 65, HTN + T2D)

In addition, he felt that the TTNs were a complement to ProACT and hence, they were another reason for sustaining his engagement:

> *And then I’ve been really impressed. I figured when I first started that I’d get sick of it and not continue, and I could easily have done that. They’re [the TTNS] a complement to the whole thing and I’ve managed to carry it on. Without them, I don’t know if I would have stuck it out* (SMP10, M, 65, HTN + T2D)

When then asked about maintaining their self-management and their interest in continuing to use ProACT after the end of the project, only one PwM said he would not be interested. Of the nine who responded in the affirmative, five responded that it would depend on the cost of the equipment and the triage service, while the remaining four said yes unequivocally, for example SMP05 (M, 61, CHD + T2D) said: “*Oh yeah, without a doubt. It was absolutely unbelievable you know. Now you know the nurses were like angels so they are*” (SMP05, M, 61, CHD + T2D).

5.3.4 The barriers to engagement in self-management during the trial

None of the PwMs had stopped using ProACT during the trial, and the majority of PwMs had no issues in continuing to self-manage, despite issues with the CareApp and devices. For instance, five of the PwMs reported issues that included devices not syncing with the iPad, equipment failures, and iPad updates not working and causing data loss. The devices that caused problems were the iPad, the blood pressure monitor and the smart watch. The PwMs were frustrated with some of the technology failures particularly with the iPad: “*I couldn’t see the logic in having a tablet and having to spend quite a bit of the time entering the stuff manually because it defeated the purpose*” (SMP04, M, 69, COPD + HTN). However, they stated that they were satisfied with the response of the Caredoc technical support team who quickly resolved the issues: “*If anything goes wrong with any of the equipment, they’ll come up and they’ll replace it or they'll update it you know, no problems with anything or no issues, that sort of thing*” (SMP01, F, 78, CHD + COPD). PwMs always felt that they could contact the team for support without ‘annoying someone’. They also appreciated the help of the TTNs who facilitated them in getting technical help. However, they also expressed concern that because there were so many issues with the technology, the TTNs were spending too much time on technical issues, although this was a concern that was not shared by the TTNs. For example: "*If there was time lost during the period of this old thing since February, the time would have been lost with the nurses trying to deal with the problems relating to technology that was kind of outside of their remit I reckon*" (SMP04, M, 69, COPD + HTN).

Another PwM (SMP10, M, 65, HTN + T2D) had stopped taking his blood glucose readings because of the expense of buying the lancets (needles) for the blood glucose monitor, he also perceived that his GP's readings were more accurate, and finally, because he felt that his blood glucose had stabilised:

> *I don't prick my fingers anymore for the sugar readings because I get it at the clinic and it's much more accurate at the doctor because of the way they do it and those needles, eventually you have to go buy them at the chemist and they weren't on the prescription and it was quite expensive. So, I just thought and I knew and I was seeing it because I was watching what I was eating, and the exercise and my weight and everything. I was getting the same readings in any case it wasn't going up and down* (SMP10, M, 65, HTN + T2D)

However, his disengagement from using the blood glucometer did not impact on his engagement with the other ProACT features he was using.

Two PwMs experienced health events during the SMILE project unrelated to their existing conditions, which prompted them to disengage from exercising temporarily during the trial. One PwM (SMP03, F, 86, CHD + COPD) had a mild stroke and had been unable to walk for six weeks while she recuperated. Similarly, SMP04 (M, 69, COPD + HTN) strained his foot which had made it difficult for him to take exercise for two months. Nonetheless, both were endeavouring to re-engage with their exercise regimes at the time of their interviews.

5.3.5 Perceptions of ProACT for self-management

Although several of the participants had little or no experience of using technology prior to the SMILE project, they adapted well to using ProACT. This was commented on by the GP, Practice Nurse and TTNs who related that they had underestimated the participants' ability to use the ProACT DHT before they commenced the trial, and were 'amazed' at how they embraced the technology: "*In a lot of cases we underestimated their ability because even though some of our participants are well into their seventies and eighties, they actually were well able to use it*" (TTN01). The PwMs spoke about how the technology kept them on track with their health, believing that self-management would be hard without it, as they would not have readings to see their health status. In addition, they felt it also alleviated any concerns they may have had about their health because they knew they were being monitored by the TTNS. Only one PwM expressed fear of the technology in regards to doing something 'wrong' such as pressing the 'wrong' button: "*I know it's stupid really, but it's this old fear of doing the wrong thing, or pressing the wrong button or whatever you know*" (SMP04, M, 69, COPD + HTN).

The HCPs were asked about their perception of the technology. The GP found that when the PwMs brought in their iPads to show him their readings, they were accurate. He stressed the importance of having the technology to support his care for the PwMs, particularly during COVID-19. The TTNs spoke about the system that they were using to monitor the PwMs, reporting that they found it simple to use: "*Yeah, I have to say the Netwell Admin system is very user friendly for us. I think it's very user friendly, it's very easy to access the data, it's lovely and clear and it's very user friendly I think as well for the PwMs themselves*" (TTN01). They also reported that having the readings on their system over a time period of a number of weeks helped them to understand the PwMs' health trends and hence, make better clinical judgements: “*Because of the way that Netwell Admin is laid out we can actually assess them properly and look at what their trends are and use what way they’re heading and do something*” (TTN01).

5.4 Theme three – the relationship between the PwMs and TTNs

This theme explores the relationship between the PwMs and TTNs. Within the theme, three sub-themes were identified. These are: (i) the nature of the relationship; (ii) the quality of the relationship; and (iii) the important aspects of the relationship. These will now be discussed below.

5.4.1 The nature of the relationship

The PwMs appeared to have formed a close bond with the TTNs, with several of them saying that they felt they knew them, even though they had never met: “*No matter who came on the line I knew who it was. I knew who it was from their voice. I always felt as if I knew them – as friends as well as nurses*” (SMP01, F, 78, CHD + COPD). The friendliness of the TTNs was commented on by several PwMs who noted that conversations were more than just about health-related matters which they appreciated, with SMP04 (M, 69, COPD + HTN) saying that he *‘had craic’* while speaking to them, although he also noted how professional they were in dealing with him. “*I did feel that over the period of time, the relationship I built up with the different [nurses], that I could have said anything to them*” (SMP04, M, 69, COPD + HTN). Finally, SMP10 (M, 65, HTN + T2D) reported that he wanted to maintain contact with the nurses after the SMILE project because of the relationship he had built with them.

TTNs shared this perception of the friendliness of their relationship saying: “*I mean we’ve built up some extraordinary relationships with these people. We haven’t even met them,* *it's phenomenal really*" (TTN01). They spoke about discussing every day topics such as the PwMs' families or what was happening in their lives, for instance. They felt that it was important to create a holistic relationship because it enabled the PwMs to benefit more from the triage service. The nurses spoke about taking time to talk to the participants and the importance of getting to know them on a deeper level. It helped them to 'pick up on cues', something that was vital to treating the PwMs appropriately because they were not dealing with them face-to-face. As one triage nurse noted: "*Our ears are our eyes, we've got so used to listening to what they're not saying if that makes sense*" (TTN03).

5.4.2 The quality of the relationship

All PwMs described the TTNs positively, with terms such as 'professional', 'kind', 'caring', 'helpful', 'supportive', and 'encouraging' used throughout the interviews. The PwMs felt confident to be able to contact the TTNs with any issues they had, mentioning that they would do so at any time and as often as they needed to because they did not feel that they were an inconvenience. One PwM spoke about the nurses taking the time to talk to him for as long as he needed them to, compared to the amount of time afforded to him by his HCPs. The PwMs also felt that they could be open and frank with them, and also 'be themselves' with them. For instance, SMP04 (M, 69, COPD + HTN) felt comfortable enough to speak to them about feeling depressed:

> *I did feel that over the period of time, the relationship I built up with the different [nurses], that I could have said anything to them. If I was in the pits of depression here and needed someone, that I could have said 'listen, have you five minutes, I need to talk to someone?' You know I felt that at ease and comfortable with them*
> (SMP04, M, 69, COPD + HTN)

The TTNs also acknowledged this: "*A lot of them say 'we know you have our backs we know you're minding us' and that in itself is hugely comforting*" (TTN03). The TTNs reported that they had very few difficulties with the PwMs, attributing this to the fact that they had wanted to participate in the project and engaged with it well from the outset. The main issue would have been needing to be persistent with some PwMs in getting them to go to the GP, something they were reluctant to do because of COVID-19.

5.4.3 The important aspects of the relationship

The PwMs were asked what they felt were the most important aspects of their relationship with the TTNs. One factor that was mentioned as important for the PwMs was the advice on health issues and on what course of action to take, such as contacting their GP. In fact, one participant (SMP10, M, 65, HTN + T2D) stated that he was more likely to contact the TTNs before he contacted his GP because of the time they spent talking to him, because he felt that their advice was better than his GPs and also because of their fast response to his high readings: "*They give you so much time that you actually get better advice from them sometimes than the GP. If I started feeling really bad, I'd probably try phoning them before I'd phone the doctor*".

The type and consistency of the contact was also important to the PwMs who felt that the TTNs were at the end of the telephone and would contact them if there was any issue with their readings: "*Knowing that I can contact them at any time and they can contact me if there's any problems whatsoever*" (SMP08, F, 65, CHD + HTN). She believed that having this level of contact with the TTNs had increased her confidence in her health and well-being. For SMP09 (M, 54, HTN + T2D), the continual contact with the TTNs alleviated his tendency to worry about his health, particularly if he believed there was something wrong. SMP10 (M, 65, HTN + T2D) felt that being able to communicate with people who were trained and could spot if there was any issue was important for him. SMP05 (M, 61, CHD + T2D) also appreciated the level of contact that he had with the TTNs and that they would check on him to make sure that he was alright.

PwMs reported that the TTNs helped to calm them down and stop stressing when they thought that something was wrong. They valued having the nurses tell them that everything was alright, offering them advice on what to do. SMP04 (M, 69, COPD + HTN) who lived alone appreciated that if he took his blood pressure and the reading was outside his normal range, he would get a call from the TTNs making sure that he was alright, or alternatively he could contact them about it. Having someone to talk to about his health worries was invaluable to him and he likened the triage service to being *'an insurance policy'*, while for SMP09 (M, 54, HTN + T2D), the triage service was like 'a safety net'. Some PwMs were happy that they were getting telephone calls from the nurses about their readings even when there was no underlying cause for concern. For example, SMP07 (M, 59, HTN + T2D) who had a heart condition welcomed being contacted when his heart rate was up due to taking exercise, because he knew the nurses were monitoring him which he found to be reassuring. Further, PwMs also reported that knowing the TTNs were picking up on issues and bringing it to their attention, instilled a sense of confidence in them.

Being consistent and conveying warmth in their tone of voice when talking to the PwMs was important to the TTNs because it helped them to build a rapport and consequently develop a high level of trust in their relationship. This was because occasionally PwMs were afraid or frustrated because of their readings, and it helped to reassure them. Rapport was fundamental to building trust with the PwMs, so that they followed the advice being given. The nurses also spoke about using their conversations as a way of assessing the PwMs' health, which was important for knowing what advice to give:

> *It's not even just about the chitchat. It allows us to, we use it as an assessment tool as well so you're talking about patients with COPD. They're telling you they're well because they're very fearful of going to the doctors a lot of the time. But in actual fact you know whether or not they're unwell whether they're talking to you in sentence or it's just one-word answers, whereas you know that the last time N03 spoke to them they were full of the chat* (TN01)

5.5 Theme four – the perceived benefits and outcomes of the SMILE programme

The final theme explores the perceptions of the PwMs regarding the benefits and outcomes for them in participating in SMILE. In addition, the HCPs share their views of what they felt that they and the PwMs gained from their participation in the trial.

5.5.1 Improvements in health and well-being

Eight PwMs reported either stabilisations in their conditions or health improvements such as fewer chest infections as reported by SMP03 (F, 86, CHD + COPD): "*I don't know if it's a miracle or what but since I've been with SMILE, I haven't seemed to get so much chest infections*" (SMP03, F, 86, CHD + COPD), and improvements in blood pressure and diabetes as reported by two PwMs. Four PwMs also talked about losing significant amounts of weight (one PwM related that they had lost five stone, a second had lost three) as a result of changes in health behaviours – taking up walking and watching their diet. SMP05 (M, 61, CHD + T2D) was walking up to five miles a day as well as cycling, things he had never done before the SMILE project, and SMP07 (M, 59, HTN + T2D) reported that he was walking twice a day since beginning his participation. Finally, SMP10 (M, 65, HTN + T2D) who was diabetic had cut down significantly on his sugar intake, resulting in the stabilisation of his diabetes.

Six of the PwMs reported that having the smart watch to record their steps and the data from the readings gave them the impetus to take more exercise. One PwM (SMP09, M, 54, HTN + T2D), made use of the exercise videos within the CareApp particularly when the weather was bad and he could not get out for a walk. He also appreciated having the readings as a way of keeping track of his health and reassuring himself that he was alright: "*Reassuring to know that you're able to check it before you start having to make adjustments or anything like that. You're able to check and just verify that what you think is happening is what's happening*" (SMP09, M, 54, HTN + T2D).

Another outcome in relation to improved health was a reduction in the number of medications that the PwMs were taking as noted by the TTNs, for example: "*We have one gentleman who had I think it was 24 courses of antibiotics and steroids in the space of a year in 2017 and this year has not had a single steroid or antibiotic since he's been on the programme*" (TTN01). Further, another PwM had managed to come off all his medication for diabetes which was also noted by TTN01: "*Amazingly we have one gentleman who lost six stone and reversed his type 2 diabetes completely. He's off his insulin and his oral hypoglycaemic…it's unbelievable what some of them have achieved with the motivation*" (TTN01).

5.5.2 Empowerment to self-manage

Another outcome of participating in SMILE was the sense of empowerment experienced by PwMs to self-manage their health. This was because of factors such as increased awareness and knowledge of their health leading to increased confidence to self-manage, increased peace of mind, and finally, more timely and appropriate health interventions. These are discussed in turn below.

5.5.2.1 Increased awareness, knowledge and confidence

Apart from health improvements, the PwMs benefitted from growing awareness and knowledge of how to look after their health better by taking exercise, eating healthily, slowing down to avoid blood pressure spikes and they also grew in knowledge about their conditions: "*Like before, I never knew about my blood pressure or my heart rate or anything, you know like, and my physical exercise that I was getting. This all came on line like when I got into SMILE*" (SMP07, M, 59, HTN + T2D). This gain in knowledge was reflected on by both the Practice Nurse and the TTNs who found that the PwMs, once they became familiar with ProACT, were able to understand their readings and recognise when they were not doing well. The GP commented on how PwMs were able to tell him what was wrong with them: "*I've been fascinated by the number of people who've come back and said 'listen, I'm tachycardic'*" (GP), or who could show him the changes in their readings on their iPad which they brought with them to their appointment.

SMP08 (F, 65, CHD + HTN) and SMP09 (M, 54, HTN + T2D) spoke about feeling more confident in managing their health, which was also noted by the Practice Nurse and the TTNs: "*As time has gone on like I think their confidence has grown massively in managing their conditions*" (TTN02). The Practice Nurse also noted the growth in confidence in the PwMs to manage their conditions and hence, they were less fearful of their illnesses: "*They're less fearful of their illness as well like*" (PN). She felt that the participants had also grown in their general self-confidence and were happier since starting their participation in the programme: "*But do you know what? They're happier*" (PN).

PwMs also learned more appropriate ways to self-manage their conditions. For example, SMP10 (M, 65, HTN + T2D) learned that taking his blood pressure during the middle of the day gave him a lower reading than if he took it first thing in the morning, as he had found that it was usually higher then. Further, he spoke about learning to recognise when his blood pressure was making him dizzy, and because of this he stopped making adjustments to his diabetes, which he had been blaming for his dizzy spells. From the GP's perspective, he acknowledged that taking their own readings helped the PwMs to take ownership of their health and produced better outcomes for them. The TTNs also reported that for the PwMs, having access to the triage service when they were unable to access their own GP during COVID-19 empowered them, knowing that they could access professional advice whenever it was needed.

5.5.2.2 Increased peace of mind

An important outcome of participating in the SMILE programme reported by the PwMs was the peace of mind they gained from being monitored by the TTNs and also from knowing their symptom and well-being readings. Being monitored alleviated concerns or worries that the PwMs had with their readings because they knew that they would be contacted by the nurses: "*You get great peace of mind from it. I don't have to worry about it because I can see it and if anything goes wrong, they'll be in touch with me to check me*" (SMP01, F, 78, CHD + COPD). Knowing that someone was checking on them helped the PwMs to feel at their best and was reassuring: "*It's nice to know that I'm being monitored. That's the jewel, like*" *(*SMP01, F, 78, CHD + COPD). Four PwMs reported having peace of mind because of being able to take their readings particularly if they were not feeling well. Taking their own readings and seeing that they were within the normal range for them gave them a sense of ease: "*I was quite happy that things were ok once I was able to do the test myself, you know, the blood pressure myself*" (SMP08, F, 65, CHD + HTN).

5.5.2.3 More timely interventions and more appropriate health care utilisation

One outcome for the PwMs of having ProACT and the TTNs' support was that they were either visiting or contacting their GPs less frequently for issues such as having their blood pressure taken. Having the TTNs respond to high readings meant that the PwMs avoided having to telephone their GP or make an appointment to visit the surgery because they were able to follow the advice given to them by the TTNs: "*I mean, between the old trial that we've done there with the oxygen levels and the blood pressure and all of that, that has prevented me needing at different times this year to have to ring the doctor*" (SMP04, M, 69, COPD + HTN). Regarding the issue of accessing health care when required, the PwMs reported that the technology meant that high blood pressure readings for example, were picked up on immediately by the TTNs which meant that they were able to get treatment quickly. The TTNs also noted the fact that the PwMs were able to get to their GP in a more timely manner due to issues being identified earlier which negated the need for a hospital visit:

> *Particularly with the COPD patients they can recognise because of the technology that their stats might be a little off. They can get to the GP quicker and inevitably that leads to no hospital stay because they've got their antibiotics or their steroids and they've started with that earlier* (TTN03)

For the GP, the main benefit for him in having his patients participate in SMILE lay in the fact that fewer of them needed to be hospitalised. He also believed that he was getting better outcomes with the patients because of having their readings and also because of the TTNs: "*When I have accurate measurements and also too backup from the nurses it makes my life a lot easier*" (GP). The Practice Nurse reported that her workload was lighter because the PwMs were not making as many appointments, and were using the triage service instead for advice: "*Well we see less of them…so I do think that takes a bit of pressure off us as the problem is sort of, being dealt with by the SMILE team. It helps a lot*" (PN).

5.6 Chapter 5 summary of findings

This chapter presented the qualitative findings from Study 1 that was conducted with 10 PwMs participating in the SMILE project, the TTNs who provided them with telephone triage support, and finally a GP and Practice Nurse from the same GP practice. From the four themes that were reported on herein, the key findings were:

Theme one – the challenges and impact of multimorbidity

Multimorbidity significantly burdened PwMs, causing pain, prolonged infections, confusion about conditions, and frequent health care visits. Despite this, most PwMs appeared to cope well, with only one mentioning mental health impacts. Health care providers also noted challenges: GPs found frequent appointments difficult for those with mobility issues, while a Practice Nurse felt that time constraints in a busy practice prevented PwMs from fully understanding the health information she provided them with.

Regarding COVID-19, four PwMs felt it affected their self-management, while six believed it had no impact. Many adapted by relying on telephone consultations or advice from the TTNs instead of face-to-face GP visits.

When discussing challenges with their HCPs, one participant reported that his serious cardiac condition had been misdiagnosed by a hospital on four occasions but it had been captured by the TTNs who alerted him to the issue and ensured he received the appropriate treatment.

Theme two – engagement in self-management of conditions

PwMs reported positive changes in self-managing their conditions such as maintaining daily routines for readings, medications, and using the CareApp which they perceived helped them to be self-reliant in self-managing their health. They felt responsible for their health, with many motivated by the TTN monitoring and visible health improvements. Eight PwMs consistently followed TTN advice, trusting their expertise, while TTNs used humour and encouragement to enhance engagement levels. During COVID-19, TTNs provided more emotional support due to increased loneliness and depression among the PwMs. Despite some technical issues, no PwMs stopped using the technology, as they felt well supported and recognised the health benefits of ProACT.

Theme three – the relationship between the PwMs and TTNs

PwMs and TTNs developed a close bond despite having never met in person. The PwMs valued the TTNs' availability for conversation, which contrasted with their experiences with HCPs. Regular and consistent contact with TTNs reassured PwMs and eased their health concerns. The TTNs built trust by being friendly and warm, which strengthened their relationship with the PwMs. This rapport enabled TTNs to pick up on subtle cues during conversations, allowing them to provide appropriate care even without face-to-face interactions.

Theme four – the perceived benefits and outcomes of the SMILE programme

Seven PwMs reported health improvements, such as condition stabilisation and fewer infections, while four participants noted increased health awareness through better diet and exercise routines. Four PwMs also gained confidence in managing their health. All PwMs highlighted benefits like peace of mind from TTN monitoring, increased motivation for exercise, fewer GP visits, and reduced medication use. HCPs also observed positive outcomes — GPs benefited from accurate readings, and the Practice Nurse noticed reduced GP practice visits due to the TTN support. The thesis now continues with the presentation of the objective engagement findings from Study 2, Part 1.

Chapter 6: Study 2 – Exploring Digital Self-Management Engagement Patterns of PwMs with and without TTN Support
Part 1

6.0 Introduction

Chapter Six presents the objective engagement data collected within the ProACT platform concerning the SEURO project PwMs' engagement with digital self-management. It includes data from PwMs with and without TTN support. The data that are reported herein pertain to: (1) overall engagement with the ProACT platform (2) the active engagement with the non-passive devices used for monitoring – the blood glucose monitor, blood pressure monitor, pulse oximeter and weighing scales; (3) engagement with the CareApp and its various features including activity goal setting and (4) TTN supports to the ProACT Plus TTN Support participants. Objective engagement data relating to the three age groups included in this study as outlined in Chapter 4, Section 4.3.2, page 104 is also reported on for the four results categories.

Data were collected in Netwell Admin as outlined in Chapter Four, Section 4.3. This chapter starts with presenting the demographic information of participants whose data were analysed as part of this study, followed by presenting the data related to the PwMs' usage of the CareApp and the devices. Additionally, the data relating to the TTNs such as the number of alerts addressed and telephone calls made to the PwMs is presented as described in Chapter Four.

6.1 Demographics

The dataset analysed consisted of data from 64 PwMs, of whom 35 (54.69%) were male and 29 (45.31%) were female. The participants, whose inclusion in this research study was previously described in Chapter Four, Section 4.3.1 were evenly split between the ProACT Plus TTN Support and ProACT No TTN cohorts, with 32 participants (50%) in each cohort. See Table 7, page 151 for details of the demographic breakdown.

Table 7: *Demographic information Study 2, Part 1 PwM participants (n=64)*

	Overall	**ProACT Plus TTN Support**	**ProACT No TTN Support**
Age Range	66-90 Years	66-90 Years	66-88 Years
Mean	74.51 Years	74.91 Years	74.10 Years
Gender *n* (%):			
Male	35 (54.69)	19 (59.38)	16 (50.00)
Female	29 (45.31)	13 (40.62)	16 (50.00)
Highest Educational Level *n* (%):			
Some Primary/Primary	2 (3.11)	2 (6.25)	0 (0.00)
Secondary	32 (50.00)	15 (46.88)	17 (53.13)
Diploma/Cert	10 (15.63)	5 (15.62)	5 (15.62)
Primary Degree	6 (9.38)	4 (12.50)	2 (6.25)
Postgrad	8 (12.50)	4 (12.50)	4 (12.50)
None/Missing	6 (9.38)	2 (6.25)	4 (12.50)
Living Status *n* (%):			
Lives Alone	20 (31.25)	8 (25.00)	12 (37.50)
Lives with Others	38 (59.38)	22 (68.75)	16 (50.00)
None/Missing	6 (9.37)	2 (6.25)	4 (12.50)
Marital Status *n* (%):			
Married	34 (53.13)	22 (68.74)	12 (37.50)
Living with Partner	1 (1.56)	0 (0.00)	1 (3.13)
Widowed	13 (20.31)	4 (12.50)	9 (28.12)
Single (Never Married)	4 (6.25)	1 (3.13)	3 (9.37)
Separated	3 (4.68)	2 (6.25)	1 (3.13)
Divorced	3 (4.68)	1 (3.13)	2 (6.25)
None/Missing	6 (9.39)	2 (6.25)	4 (12.50)
Condition Profile *n* (%):			
CHD + CHF	2 (3.12)	1 (3.13)	1 (3.13)
CHD + Resp.	3 (4.68)	2 (6.25)	1 (3.13)
CHD + T2D	4 (6.25)	1 (3.13	3 (9.36)
CHF + CVD	4 (6.25)	3 (9.36)	1 (3.13)
CHF + HTN	3 (4.68)	3 (9.36)	0 (0.00)
CHF + Resp.	1 (1.57)	1 (3.13)	0 (0.00)
CHF + T2D	2 (3.12)	0 (0.00)	2 (6.25)
CVD + Resp.	6 (9.38)	4 (12.50)	2 (6.25)
CVD + T2D	9 (14.07)	4 (12.50)	5 (15.62)
HTN + Resp.	7 (10.93)	2 (6.25)	5 (15.62)
HTN + T2D	4 (6.25)	2 (9.36)	2 (6.25)
Resp. + T2D	3 (4.68)	0 (0.00)	3 (9.36)
CHD + HTN + Resp.	3 (4.68)	3 (9.36)	0 (0.00)
CHD + HTN + T2D	2 (3.12)	1 (3.13)	1 (3.13)
CHD + Resp. + T2D	2 (3.12)	1 (3.13)	1 (3.13)
CHF + CVD + Resp.	1 (1.57)	1 (3.13)	0 (0.00)
CHF + HTN + Resp.	1 (1.57)	0 (0.00)	1 (3.13)
CHF + HTN + T2D	1 (1.57)	0 (0.00)	1 (3.13)
CVD + HTN + T2D	1 (1.57)	0 (0.00)	1 (3.13)
CVD + Resp. + T2D	1 (1.57)	1 (3.13)	0 (0.00)
HTN + Resp. + T2D	3 (4.68)	1 (3.13)	2 (6.25)
CHD + HTN + Resp. + T2D	1 (1.57)	1 (3.13)	0 (0.00)

6.2 PwMs' overall engagement with ProACT

Any engagement by trial cohort: The findings show that across the ProACT platform, PwMs across the ProACT Plus TTN Support and ProACT No TTN Support cohorts on average used the platform, i.e., engaged with either a device or the CareApp, approximately the same percentage of days during the 26-week period (week two to week 27) reported herein (Figure 20 below). On average, ProACT Plus TTN Support PwMs engaged on 75.22% of days, while ProACT No TTN Support PwMs engaged on 73.91% of days. The highest level of usage saw interaction on 99% of days by ProACT Plus TTN Support PwMs and 100% of days by ProACT No TTN Support PwMs, while the lowest level of usage was 21% of days by ProACT Plus TTN Support PwMs and 38% by ProACT No TTN Support PwMs.

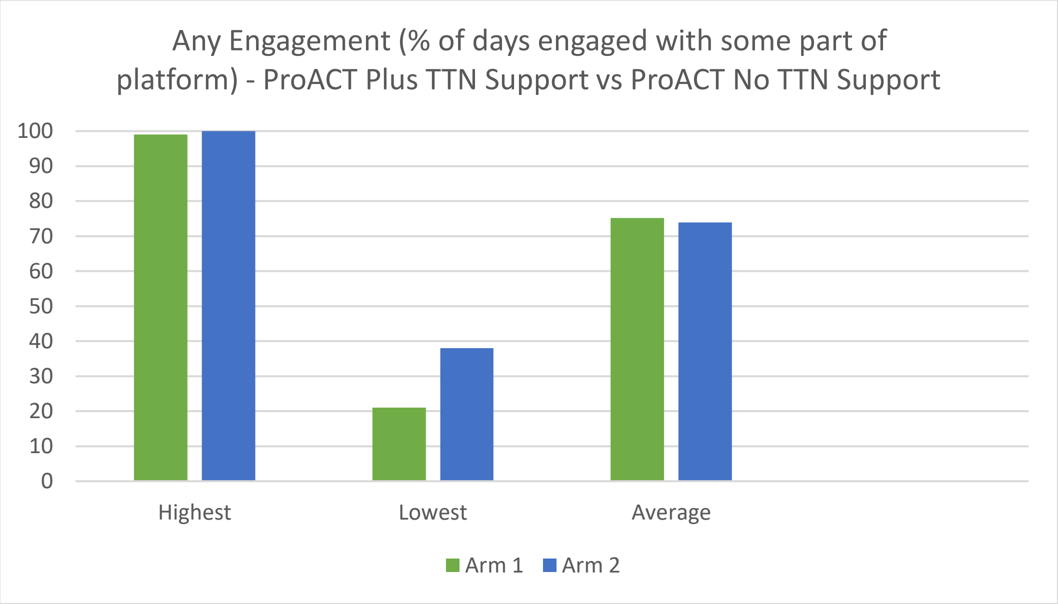


Figure 20: Study 2, Part 1 any engagement by trial cohort

Any engagement by trial cohort and age group: Across the platform, ProACT Plus TTN Support PwMs in the 85+ years age group recorded the highest average percentage of days engagement (87.25%), while conversely, ProACT No TTN Support's 85+ years age group participants had the lowest level of engagement across cohorts and age groups, which was on 52.33% of days (Figure 21 below). This was also the largest difference in engagement between the two cohorts' age groups. Meanwhile, the smallest difference in engagement between the age groups was recorded in the 75-84 years age group, with ProACT Plus TTN Support PwMs engaging with some part of the platform on 85.31% of days compared to ProACT No TTN Support PwMs who engaged slightly less, on 83.71% of days. Finally, the ProACT No TTN Support 65-74 years age group engaged more (72.23% days engaged) than their ProACT Plus TTN Support counterparts (63.27% days engaged).

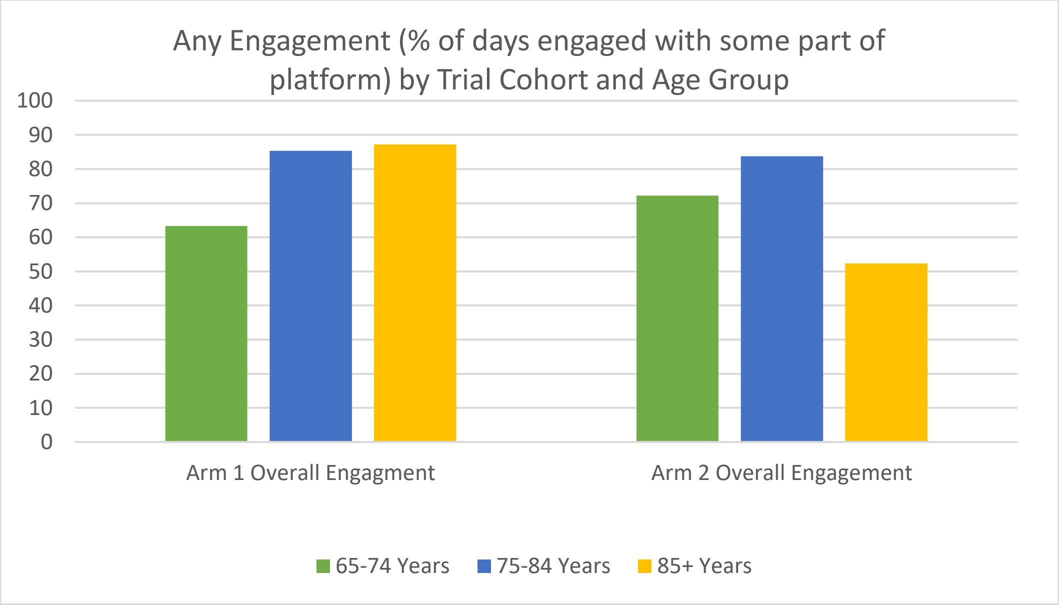


Figure 21: Study 2, Part 1 any engagement by trial cohort and age group

Tables 8 and 9 (pages 155 and 156) present an overview of engagement per participant across the ProACT Plus TTN Support and ProACT No TTN Support cohorts respectively. The tables outline each participant's age range, conditions, devices used during the SEURO trial, their percentage of days engaged with any part of the ProACT platform, the CareApp (i.e., opening the CareApp) and its sections (i.e., navigating to its different sections), as well as the total number of vitals measures each participant took over the course of the trial. It should be noted that in relation to the total number of vitals measures, this is inclusive of heart rate measures. As previously noted in Chapter 4, Section 4.4.1, heart rate was excluded from more detailed analysis of the vitals data (Section 6.3) as it is measured using either the blood pressure or pulse oximeter device. However, the total number of measures data for individual participants available within Netwell Admin includes heart rate.

Table 8: *Study 2, Part 1 ProACT Plus TTN Support participants (n=32), devices, percentage of days' any engagement and engagement with the CareApp and its sections, total number of vitals measures*

				% of Days Engaged Weeks 2 to 27							Measures (n)
ID	**Age Group**	**Conditions**	**Devices**	**Any Engagement**	**CareApp**	**Vitals**	**Activity**	**Self report**	**Education**	**Medication**	**Vitals**
SEP02	75-84	CHD + COPD + HTN	BPM, pulse ox., weight	96	82	82	25	20	12	29	901
SEP05	65-74	CHD + HTN + T2D	BGM, BPM, weight	70	47	38	41	12	10	40	461
SEP07	85+	CHF + HTN	BPM, weighing scales	95	26	8	8	6	15	9	515
SEP09	75-84	CHD + COPD + HTN + T2D	BGM, BPM, pulse ox., weight	59	56	55	27	16	2	5	580
SEP10	65-74	CHD + HTN + T2D	BGM, BPM, weight	75	73	70	54	14	4	71	696
SEP12	85+	CHD + CHF + HTN	BPM, weight	93	7	3	2	2	1	3	214
SEP15	75-84	CHD + COPD + T2D	BGM, BPM, pulse ox., weight	93	93	93	0	16	0	93	879
SEP16	75-84	CHD + COPD + HTN.	BPM, pulse ox., weight	51	44	38	5	15	3	6	274
SEP18	75-84	CHD + HTN + Resp.	BPM, pulse ox., weight	98	95	94	27	25	5	7	732
SEP20	65-74	CHD + T2D	BGM, BPM, weight	54	30	27	7	4	1	4	338
SEP25	65-74	CHD + T2D	BGM, BPM, weight	23	0	0	0	0	0	0	104
SEP43	75-84	CHD + COPD + HTN	BPM, pulse ox., weight	99	98	96	86	95	4	24	686
SEP47	75-84	COPD + HTN + Resp.	BPM, pulse ox., weight	93	90	89	88	10	1	2	655
SEP55	65-74	CHF + HTN + Resp.	BPM, pulse ox., weight	96	81	81	0	1	1	2	625
SEP62	65-74	CHD + HTN + Resp.	BPM, pulse ox., weight	39	39	38	7	6	2	4	316
SEP65	65-74	CHD + Resp.	BPM, pulse ox., weight	84	57	51	12	50	3	8	475
SEP69	65-74	CHD + HTN + COPD + T2D	BGM, BPM, pulse ox., weight	28	16	16	1	2	2	5	244
SEP79	65-74	CHD + COPD + Resp.	BPM, pulse ox., weight	81	81	75	27	40	6	80	620
SEP82	75-84	HTN + T2D	BGM, BPM, weight	87	53	49	4	14	2	2	723
SEP88	65-74	COPD + HTN.	BPM, pulse ox., weight	79	49	38	32	34	2	42	378
SEP90	75-84	COPD + T2D	BGM, BPM, pulse ox., weight	76	76	75	4	4	5	9	658
SEP99	65-74	HTN + Resp.	BPM, pulse ox., weight	21	10	8	5	8	1	5	122
SEP100	65-74	COPD + HTN	BPM, pulse ox., weight	65	49	37	19	5	5	47	378
SEP105	65-74	CHF + Resp.	BPM, pulse ox., weight	54	37	34	10	12	1	28	278
SEP110	75-84	CHD + COPD + HTN + Resp.	BPM, pulse ox., weight	98	98	98	54	32	3	98	653
SEP125	75-84	CHD + COPD + HTN + T2D	BGM, BPM, pulse ox., weight	97	97	97	25	14	6	94	1307
SEP132	75-84	HTN + T2D	BGM, BPM, weight	70	35	35	0	0	0	0	968
SEP134	65-74	CHF + HTN	BPM, weight	98	98	7	19	2	2	98	886
SEP137	85+	CHF + HTN	BPM, weight	84	29	19	9	14	1	4	635
SEP140	85+	CHF + HTN	BPM, weight	77	8	5	2	4	4	5	159
SEP144	65-74	CHD + T2D	BGM, BPM, weight	82	62	61	3	2	1	11	571
SEP146	75-84	CHD + CHF	BPM, weight	92	17	14	5	7	7	10	610
			Average % of days engaged	**75.22**	**54.16**	**47.84**	**19.00**	**15.19**	**3.50**	**26.41**	**Average: 551**

Legend: BGM = blood glucose monitor, BPM = blood pressure monitor, pulse oximeter = pulse ox, weight = weighing scales

Table 9: *Study 1, Part 1 ProACT No TTN Support participants (n=32), devices, percentage of days' any engagement and engagement with the CareApp and its sections, total number of vitals measures*

				% of Days Engaged Weeks 2 to 27							Measures (n)
ID	**Age Group**	**Conditions**	**Devices**	**Any Engagement**	**CareApp**	**Vitals**	**Activity**	**Self report**	**Education**	**Medication**	**Vitals**
SEP01	65-74	CHD + HTN + T2D	BGM, BPM, weight	34	1	0	1	0	0	1	64
SEP03	65-74	HTN + Resp. + T2D	BGM, BPM, pulse ox., weight	30	4	2	1	2	1	1	60
SEP04	75-84	COPD + HTN.	BPM, pulse ox., weight	54	5	3	2	2	1	3	260
SEP06	65-74	CHF + CHD + HTN	BPM, weight	35	3	2	0	1	0	2	60
SEP08	65-74	CHD + T2D	BGM, BPM, weight	93	66	65	2	5	1	4	978
SEP11	65-74	COPD + T2D	BGM, BPM, pulse ox., weight	93	93	93	1	64	1	60	545
SEP13	65-74	CHD + T2D	BGM, BPM, weight	84	58	46	7	6	0	2	471
SEP14	75-84	CHD + HTN + T2D	BGM, BPM, weight	80	73	69	3	17	7	11	614
SEP17	65-74	COPD + HTN + Resp.	BPM, pulse ox., weight	42	31	24	7	8	1	17	183
SEP19	85+	CHD + T2D	BGM, BPM, weight	54	34	31	0	2	6	6	344
SEP23	65-74	HTN + T2D	BGM, BPM, weight	45	3	2	2	2	1	2	108
SEP26	65-74	CHD + COPD + T2D	BPM, pulse ox., weight	86	84	83	1	2	1	2	767
SEP32	75-84	HTN + T2D	BGM, BPM, weight	92	92	92	10	5	6	86	1161
SEP40	65-74	CHD + HTN + T2D	BGM, BPM, weight	100	82	81	3	16	2	4	691
SEP42	65-74	Resp. + T2D	BGM, BPM, pulse ox., weight	92	3	2	2	1	2	2	631
SEP46	75-84	CHD + HTN +T2D	BGM, BPM, weight	93	80	76	3	4	1	60	594
SEP48	65-74	COPD + HTN	BPM, pulse ox., weight	98	98	97	7	33	3	81	1169
SEP54	65-74	CHD + COPD + HTN +Resp.	BPM, pulse ox., weight	51	6	3	4	2	1	2	145
SEP56	65-74	CHF + HTN + Resp.	BPM, pulse ox., weight	77	35	30	9	4	5	6	340
SEP60	65-74	HTN + T2D	BGM, BPM, weight	96	90	90	2	3	1	3	601
SEP61	75-84	HTN + Resp. + T2D	BGM, BPM, pulse ox., weight	74	48	39	38	15	10	39	314
SEP67	65-74	COPD + Resp.	BPM, pulse ox., weight	55	54	54	4	36	0	23	641
SEP68	65-74	Resp. + T2D	BGM, BPM, pulse ox., weight	79	43	43	15	1	1	7	625
SEP70	65-74	CHD + T2D	BGM, BPM, weight	94	94	93	2	16	4	87	853
SEP80	75-84	CHD + T2D	BGM, BPM, weight	96	5	3	0	1	0	1	531
SEP96	65-74	COPD + HTN	BPM, pulse ox., weight	97	96	84	5	7	8	85	638
SEP109	65-74	CHF + T2D	BGM, BPM, weight	93	88	88	7	1	0	5	609
SEP116	65-74	COPD + HTN	BPM, pulse ox., weight	77	72	69	21	14	3	5	541
SEP121	65-74	COPD + HTN + T2D	BGM, BPM, pulse ox., weight	38	29	29	1	1	1	1	341
SEP127	85+	COPD + HTN	BPM, pulse ox., weight	75	2	1	1	0	1	1	401
SEP138	75-84	CHD + CHF	BPM, weight	97	3	0	0	1	0	1	477
SEP143	85+	CHF + T2D	BGM, BPM, weight	61	3	2	1	1	1	1	261
			Average % of days engaged	**73.91**	**46.19**	**43.63**	**5.06**	**8.53**	**2.19**	**19.09**	**Average: 501**

Legend: BGM = blood glucose monitor, BPM = blood pressure monitor, pulse ox. = pulse oximeter, weight = weighing scales

6.3 Engagement with health monitoring devices

The number of vitals measures taken by trial cohort**:** When looking at the numbers of measures taken with the devices (and excluding heart rate measures), of the total number of 14,106 measures taken, overall, ProACT Plus TTN Support PwMs took more measures than ProACT No TTN Support PwMs (7,545 vs 6,561) (Table 10, page 158). This was also the case with all of the devices except the blood glucometer, with ProACT No TTN Support PwMs taking the greater number compared to ProACT Plus TTN Support PwMs (1,069 vs 763 measures). Further, ProACT Plus TTN Support PwMs took a higher average number of measures per week from week 2 to week 27 than ProACT No TTN Support PwMs (290.19 vs 252.35), with the total average number of measures taken per week being 542.54. In considering this data, it is important to remember that all participants received a blood pressure monitor and weight scales (n=32 ProACT Plus TTN Support, n=32 ProACT No TTN Support), while those with diabetes received a blood glucometer (n=12 ProACT Plus TTN Support, n=21 ProACT No TTN Support) and those with a respiratory condition received a pulse oximeter (n=19 ProACT Plus TTN Support, n=16 ProACT No TTN Support). When this is taken into account, the average number of blood glucose measures taken per participant by ProACT Plus TTN Support PwMs is 63.60, while the average number taken per participant by ProACT No TTN Support PwMs is 50.90. The average number of blood pressure measures taken per participant by ProACT Plus TTN Support PwMs is 80.25, while the average number taken per participant by ProACT No TTN Support PwMs is 71.66. The average number of pulse oximeter measures taken per participant by ProACT Plus TTN Support PwMs is 81.60, and by ProACT No TTN Support PwMs is 49.30. Finally, the average number of weighing scales measures taken per participant by ProACT Plus TTN Support PwMs is 83.25, and by ProACT No TTN Support PwMs is 75.34.

Table 10: *Study 2, Part 1 number of measures taken by trial cohort*

Trial Cohort	Blood Glucometer	Average No. of Measures per PwM	Blood Pressure Monitor	Average No. of Measures per PwM	Pulse Oximeter	Average No. of Measures per PwM	Weighing Scales	Average No. of Measures per PwM	Totals	Average No. of Measures per Week
ProACT Plus TTN Support	763 (n=12)	63.60	2568 (n=32)	80.25	1550 (n=19)	81.60	2664 (n=32)	83.25	**7545**	**290.19**
ProACT No TTN Support	1069 (n=21)	50.90	2293 (n=32)	71.66	788 (n=16)	49.30	2411 (n=32)	75.34	**6561**	**252.35**
Totals	**1832**	**114.50**	**4861**	**151.91**	**2338**	**130.90**	**5075**	**158.59**	**14106**	**542.54**

The number of vitals measures taken by trial cohort and age group: Within the ProACT Plus TTN Support cohort, there were fifteen PwMs in the 65-74 years age group, 13 in the 75-84 years age group and four in the 85+ years age group. In the ProACT No TTN Support cohort, there were 22 PwMs in the 65-74 years age group, seven in the 75-84 years age group and three in the 85+ years age group. The highest total number of measures (4,456) was taken by ProACT No TTN Support's 65-74 age group PwMs (n=22), while the lowest total number taken was 418 by ProACT No TTN Support's 85+ years age group (n=3) (Figure 22, page 159).

In the ProACT Plus TTN Support cohort, the number of PwMs in the 65-74 years age group using a blood glucometer was six and using a pulse oximeter was nine. In the 75-84 years age group the number of PwMs using a blood glucometer was six and using a pulse oximeter was 10. No PwMs in the 85+ years age group had diabetes or a respiratory condition, and therefore did not use a glucometer or pulse oximeter. In ProACT No TTN Support, the number of PwMs in the 65-74 years age group using a blood glucometer was 14 and using a pulse oximeter was 13. In the 75-84 years age group the number of PwMs using a blood glucometer was five and using a pulse oximeter was two. In the 85+ years age group the number of PwMs using a blood glucometer was two and using a pulse oximeter was one. By device, ProACT No TTN Support's 65-74 years age group also took the highest number of measures which were with the weighing scales (1,517 measures). The lowest number of measures by device was taken by ProACT No TTN Support's 85+ years age group with both the blood glucose monitor and the pulse oximeter – one measure for each device (n=2 received a blood glucometer, n=1 received a pulse oximeter). The highest average number of measures taken per week from week 2 to week 27 were by ProACT No TTN Support's 65-74 years age group (171.38), while ProACT No TTN Support's 85+ years age group took the lowest average number of measures (16.08).

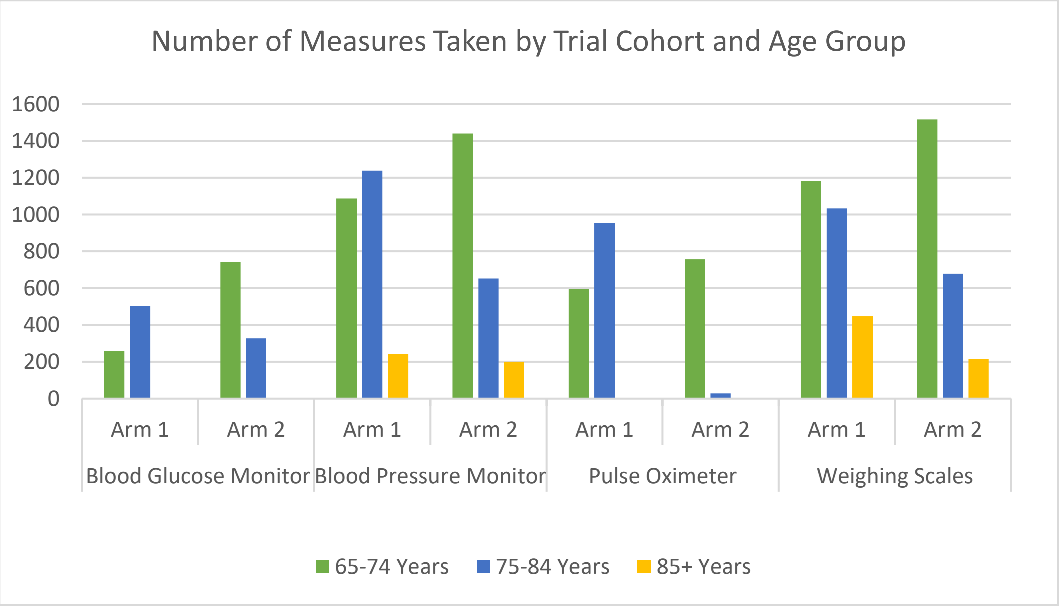


Figure 22: Study 2, Part 1 number of measures taken by trial cohort and age group

6.4 Engagement with the CareApp and its features

The CareApp by trial cohort: Overall CareApp engagement (opening the CareApp) was slightly higher by ProACT Plus TTN Support's PwMs (engagement on 54.16% of days) than by ProACT No TTN Support's PwMs (engagement on 46.19% of days) (Tables 8 and 9, pages 155 and 156 and Figure 23 below). In examining the engagement with the vitals section of the CareApp (i.e., visiting any of those sections displaying detailed trend data of the various vitals parameters), this occurred on 47.84% of days for ProACT Plus TTN Support PwMs, while the level of engagement for ProACT No TTN Support PwMs was slightly lower at 43.63% of days (Tables 8 and 9 and Figure 23).

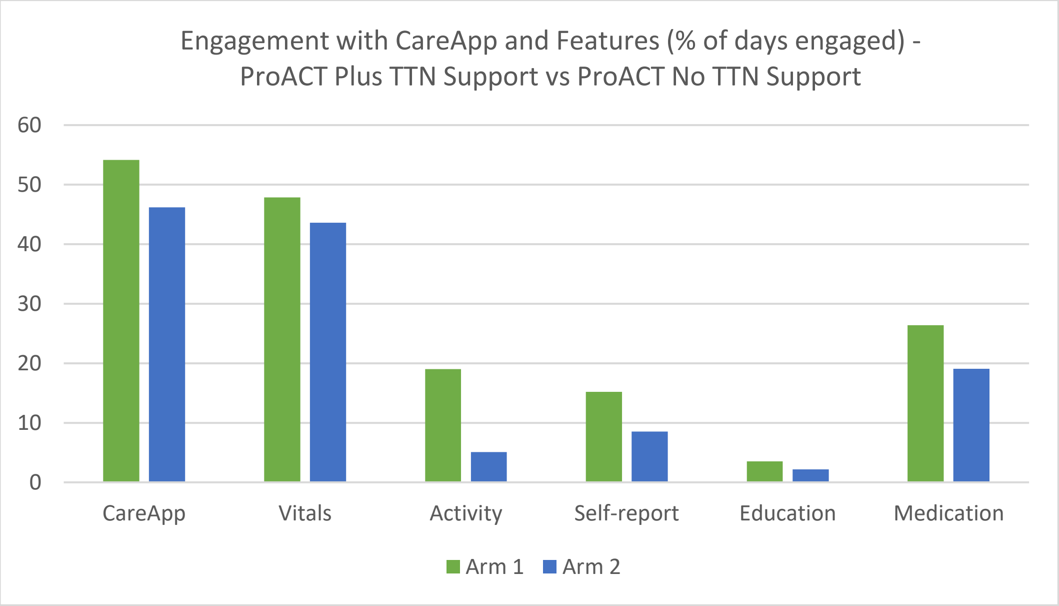


Figure 23: Study 2, Part 1 engagement with the CareApp and features by trial cohort

As can be further seen in Tables 8 and 9 and Figure 23, ProACT Plus TTN Support PwMs engaged with the activity, self-report, education and medication sections of the CareApp on a higher percentage of days than ProACT No TTN Support PwMs. After vitals, the highest engagement level for both cohorts was with the medication feature (26.41% of days for ProACT Plus TTN Support PwMs and 19.09% of days for ProACT No TTN Support PwMs). The lowest level of engagement also for both cohorts was with the education feature (3.50% of days for ProACT Plus TTN Support PwMs and 2.19% of days for ProACT No TTN Support PwMs).

When examining the number of self-report surveys completed (i.e., questions in relation to mood, anxiety, and/or respiratory and heart failure symptoms), ProACT Plus TTN Support PwMs (n=32) completed 2,636 while ProACT No TTN Support PwMs (n=32) completed 1,403 (Table 11 below). The average number of self-report surveys completed by ProACT Plus TTN Support PwMs was 82.38, significantly greater than the average number completed by ProACT No TTN Support PwMs which was 43.84. On average, ProACT Plus TTN Support PwMs completed 3.06 surveys per week, while ProACT No TTN Support PwMs completed 1.72 per week. Further, eight people in the ProACT Plus TTN Support cohort and 15 in the ProACT No TTN Support cohort never answered a self-report survey.

Table 11: *Study 2, Part 1 number of self-report surveys completed by trial cohort*

Trial Cohort	Number of Self-report Surveys Completed	Average Number of Self-report Surveys Completed	Average Number of Self-report Surveys Completed Each Week	Number of Participants who Did Not Complete Self-report Surveys
ProACT Plus TTN Support	2636	82.38	3.06	8
ProACT No TTN Support	1403	43.84	1.72	15

***Activity goal setting by trial cohort*:** In the ProACT Plus TTN Support cohort, 13 PwMs set an activity goal, while 11 set one in the ProACT No TTN Support cohort (Figure 24, page 162). The number of goals set by ProACT Plus TTN Support PwMs was 22 and by ProACT No TTN Support PwMs was 13. Further, the average number of weeks a goal was set by ProACT Plus TTN Support PwMs was 21.69 and by ProACT No TTN Support PwMs the number of weeks was 21, with the average number of weeks that a goal was met being 6.38 for ProACT Plus TTN Support PwMs and for ProACT No TTN Support PwMs the number was nine.

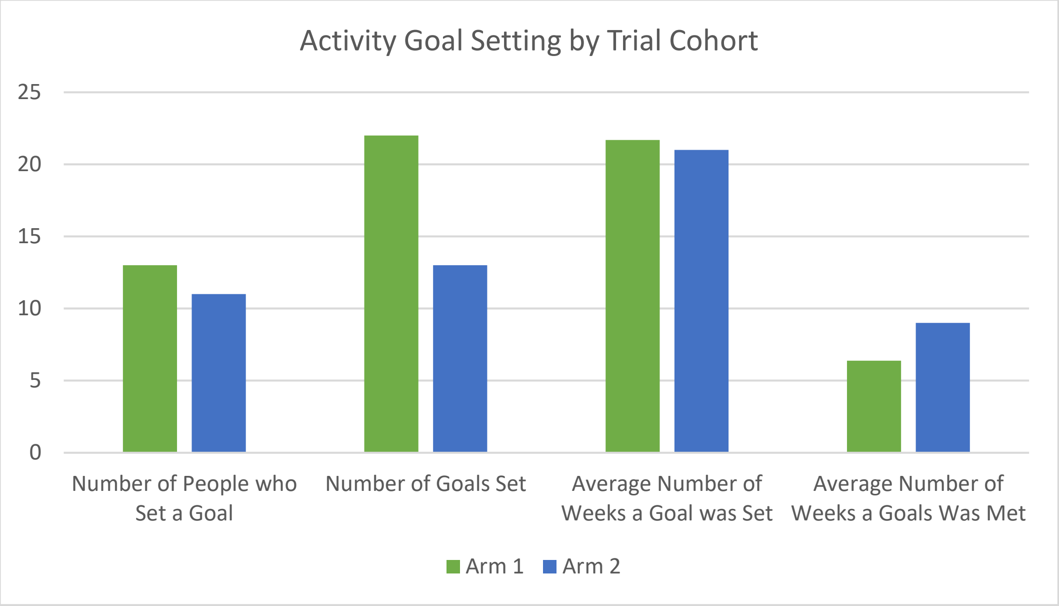


Figure 24: Study 2, Part 1 activity goal setting by trial cohort

The CareApp by trial cohort and age group: In examining engagement levels by age group, ProACT Plus TTN Support PwMs in the 75-84 years age group (n=13) had the highest level of days engagement (71.85%) with the CareApp, whilst the lowest level of days engagement was that of ProACT No TTN Support PwMs in the 85+ age group (n=3) on 13% of days (Table 12 and Figure 25, page 163 and Figure 26, page 164). Further, ProACT Plus TTN Support's 75-84 years age group PwMs engaged significantly more than their ProACT No TTN Support (n=7) counterparts (71.85% vs 43.71% days engaged). However, the difference in engagement between the cohorts in the other two age groups with the CareApp was significantly smaller. The ProACT Plus TTN Support's 65-74 years age group (n=15) PwMs engaged slightly less (48.60% days engaged) compared to ProACT No TTN Support's PwMs (n=22) who engaged on 51.50% of days engaged, while ProACT Plus TTN Support's 85+ years age group (n=4) PwMs engaged slightly more (17.50% days engaged) than ProACT No TTN Support's PwMs (13% days engaged).

Table 12: *Study 2, Part 1 ProACT Plus TTN Support and ProACT No TTN Support PwMs' (n=64) percentage of days' engagement with the CareApp and its features by trial cohort and age group*

		% of Days Engaged Weeks 2 to 27					
Trial Cohort and Age Group	**Number of Participants**	**CareApp**	**Vitals**	**Activity**	**Self-report**	**Education**	**Medication**
ProACT Plus TTN Support 65-74 Years	15	48.60	38.73	15.80	12.80	2.73	29.67
ProACT No TTN Support 65-74 Years	22	51.50	49.09	4.73	10.23	1.68	18.27
ProACT Plus TTN Support 75-84 Years	13	71.85	70.38	26.92	20.62	3.85	29.15
ProACT No TTN Support 75-84 Years	7	43.71	40.29	8.00	6.43	3.57	28.71
ProACT Plus TTN Support 85+ Years	4	17.50	8.75	5.25	6.50	5.25	5.25
ProACT No TTN Support 85+ Years	3	13.00	11.33	0.67	1.00	2.67	2.67

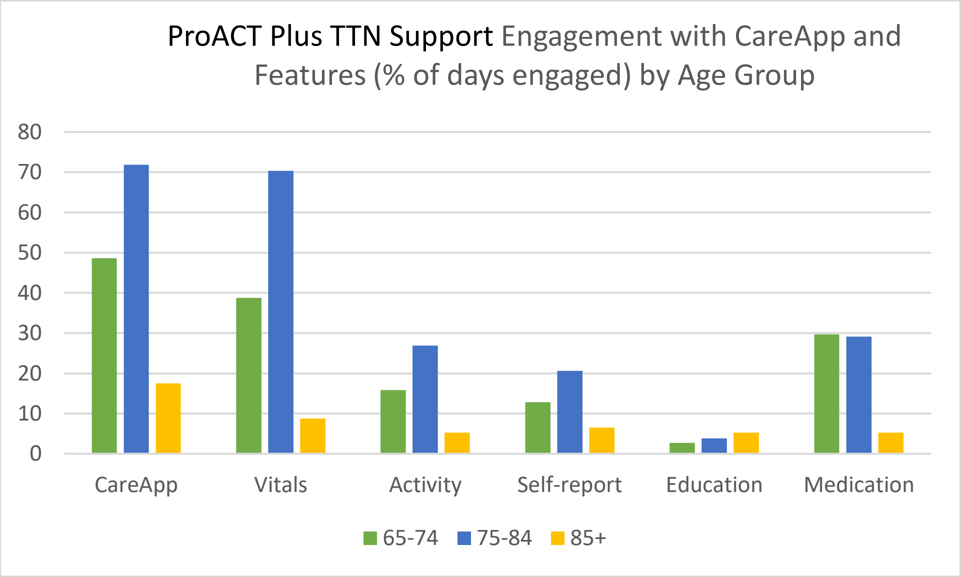


Figure 25: Study 2, Part 1 ProACT Plus TTN Support engagement with the CareApp and its features by age group

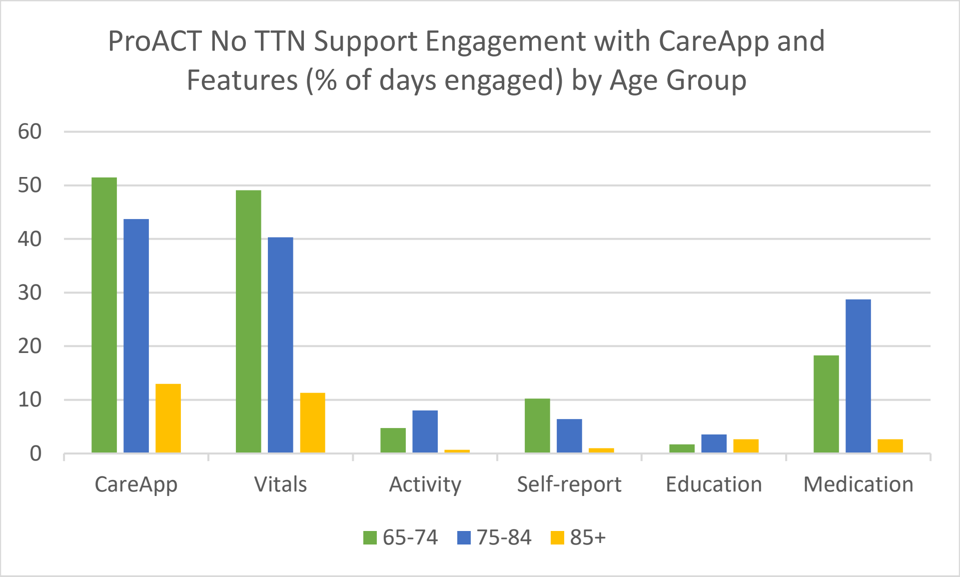


Figure 26: Study 2, Part 1 ProACT No TTN Support engagement with the CareApp and its features by age group

ProACT Plus TTN Support's 75-84 age group PwMs had the highest level of engagement with the vitals section of the CareApp (70.38% days engaged) across all age groups and both trial cohorts (Table 12 and Figure 25, page 163 and Figure 26 above). Meanwhile, the lowest level of days engagement with the vitals section was recorded by the 85+ years age group (8.75% days engaged) from the ProACT Plus TTN Support cohort. In the 65-74 years age group the ProACT No TTN Support PwMs engaged more than ProACT Plus TTN Support's PwMs (49.09% vs 38.73% days engaged), in the 75-84 years age group ProACT Plus TTN Support's PwMs engaged substantially more than ProACT No TTN Support's PwMs (70.38% vs 40.29% days engaged) and in the 85+ years group ProACT No TTN Support's PwMs engaged slightly more than ProACT Plus TTN Support's PwMs 11.33% vs 8.75 days engaged).

In relation to the additional sections of the CareApp (activity, self-report, education and medication), by age group and across both cohorts, the highest level of engagement was with the medication feature. ProACT Plus TTN Support's 65-74 years age group had the highest engagement with this feature (29.67% days engaged), while ProACT No TTN Support's

85+ years age group had the lowest engagement with it (2.67% days engaged). The lowest level of engagement across all age groups and trial cohorts was with the education feature, with the highest level of engagement with it being in ProACT Plus TTN Support's 85+ years age group (5.25% days engaged) and the lowest level of engagement in the 65-74 years age group (1.68% days engaged).

ProACT Plus TTN Support's 65-74 years age group completed the highest number of self-report surveys (1,306) while the lowest number completed was 106 by ProACT No TTN Support's 75-84 years age group PwMs (Table 13 below). The 85+ years age group PwMs from the ProACT No TTN Support cohort completed no surveys. Meanwhile, the highest average number of surveys was completed by ProACT Plus TTN Support's 75-84 years age group (93.77), while conversely ProACT No TTN Support's 75-84 years age group PwMs completed the lowest average number (15.14). Across all age categories in both trial cohorts, some PwMs did not complete any surveys, with the highest number (nine) of those PwMs coming from ProACT No TTN Support's 65-74 years age group.

Table 13: *Study 2, Part 1 number of self-report surveys completed by trial cohort and age group*

Trial Cohort	Number of Participants	Number of Self-report Surveys Completed	Average Number of Self-report Surveys Completed	Average Number of Self-report Surveys Completed Each Week	Number of Participants who Did Not Complete Self-report Surveys
ProACT Plus TTN Support 65-74 Years	15	1306	87.07	3.33	5
ProACT No TTN Support 65-74 Years	22	1297	58.95	2.72	9
ProACT Plus TTN Support 75-84 Years	13	1219	93.77	3.31	2
ProACT No TTN Support 75-84 Years	7	106	15.14	0.71	3
ProACT Plus TTN Support 85+ Years	4	111	27.75	1.25	1
ProACT No TTN Support 85+ Years	3	0	0	0	3

Activity goal setting by trial cohort and age group**:** The age group with the most PwMs to set an activity goal was the 65-74 years age group (17) and this group set the highest number of goals (25) (Table 14 below and Figure 27, page 167). They also set goals on an average of 21.89 weeks for the ProACT Plus TTN Support cohort and 22.13 for the ProACT No TTN Support cohort, but met these goals on an average of 6.22 and 7 weeks respectively. ProACT Plus TTN Support's 75-84 years group PwMs set more goals than ProACT No TTN Support's (19.67 vs 14) but it was the ProACT No TTN Support cohort who met more goals (10 vs 7). Meanwhile, the two 85+ years age group PwMs (one from each cohort) each set goals on an average of 26 weeks which was the highest average number of weeks a goal was set. In addition, the ProACT No TTN Support PwM in this age group met the activity goals on the highest average number of weeks (23).

Table 14: *Study 2, Part 1 activity goal setting by trial cohort and age group*

Trial Cohort and Age Group	Number of Participants	Number of People who Set a Goal	Number of Goals Set	Average Number of Weeks a Goal was Set	Average Number of Weeks a Goals was Met
ProACT Plus TTN Support 65-74 Years	15	9	17	21.89	6.22
ProACT No TTN Support 65-74 Years	22	8	8	22.13	7.00
ProACT Plus TTN Support 75-84 Years	13	3	4	19.67	7.00
ProACT No TTN Support 75-84 Years	7	2	4	14.00	10.00
ProACT Plus TTN Support 85+ Years	4	1	1	26.00	6.00
ProACT No TTN Support 85+ Years	3	1	1	26.00	23.00

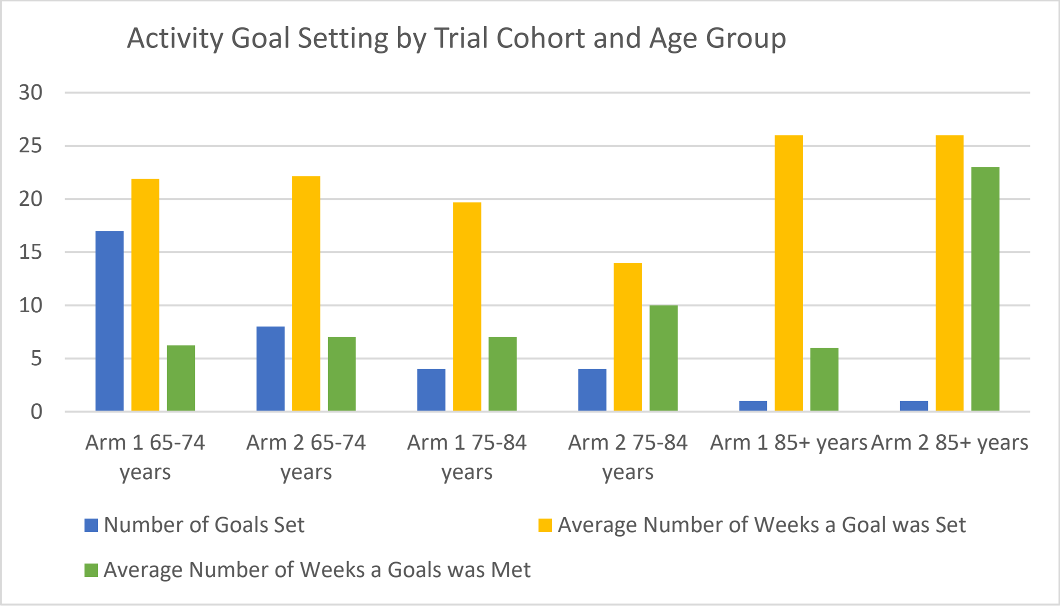


Figure 27: Study 2, Part 1 activity goal setting by trial cohort and age group

6.5 TTN supports to ProACT Plus TTN Support PwMs

TTN supports to ProACT Plus TTN Support PwMs overall: Over the 26 weeks of the trial, a total of 430 phone calls were made by the TTNs (Figure 28, page 168) to the 32 ProACT Plus TTN Support PwMs. Of these phone calls, 192 were scheduled and 238 were unscheduled. In week two, the highest number of calls per week was made (30), while nine was the lowest number of calls made which occurred twice, in weeks eight and 12.

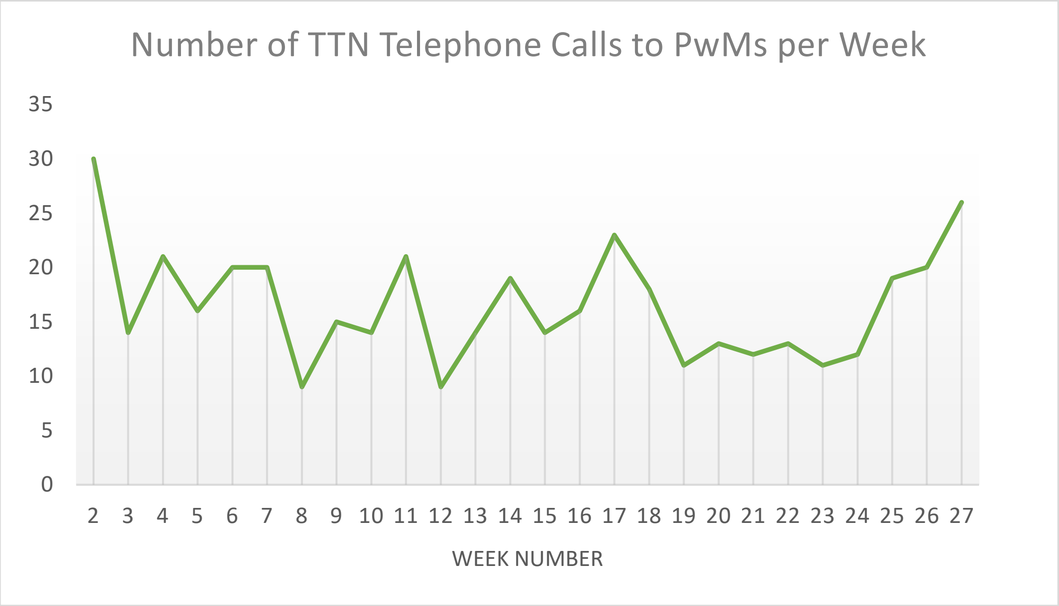


Figure 28: Study 2, Part 1 number of TTN telephone calls to PwMs (n=32) per week

Arising from the TTNs' phone calls, 37 referrals to other HCPs were made in total to 16 PwMs (Table 15 below). The majority of referrals (34) were for the GP, one was made for emergency care and two other (unspecified) referrals were made. No referrals were made for specialist care. Further, of the 16 PwMs who received a referral, eight PwMs received more than one GP referral and three PwMs received two types of referral – two PwMs received one GP and one other referral each and one PwM received one referral for the GP and one for emergency care.

Table 15: *Study 2, Part 1 referrals to other HCPs*

Referral Type	Number of PwMs who Received a Referral	Number
GP	16	34
Specialist	0	0
Emergency Care	1	1
Other	2	2

As noted in Chapter 4, Section 4.1.2, alerts were generated in Netwell Admin if a participant's reading was outside their personalised range. In total, the TTNs dealt with 1,625 alerts, of which 324 were addressed and 1,301 were dismissed (Figure 29 below). The largest number of alerts were related to blood pressure readings from the blood pressure monitor (1,094), while oxygenation levels from the pulse oximeter caused the smallest number (58).

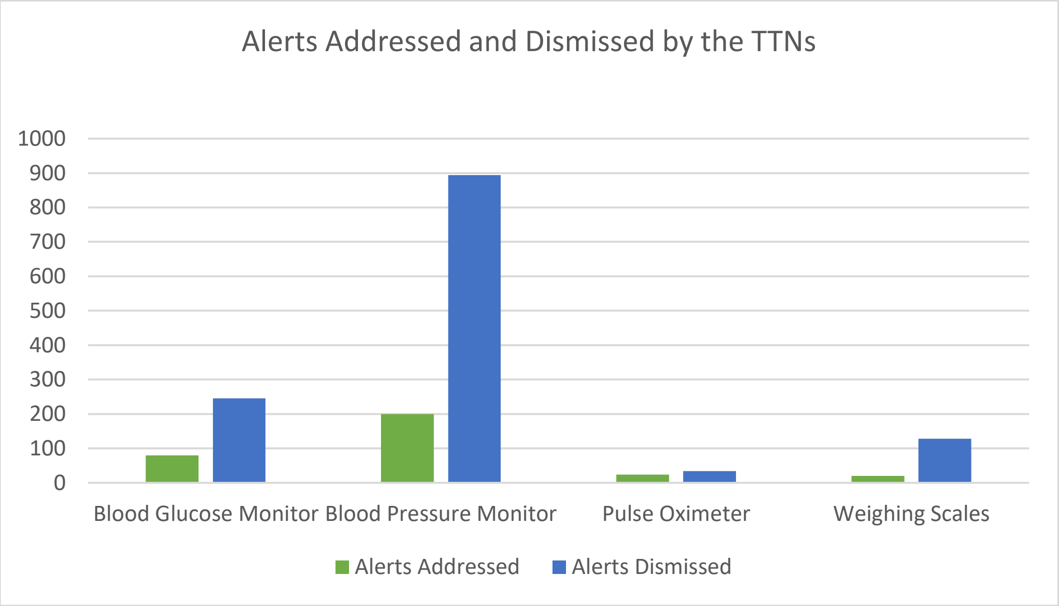


Figure 29: Study 2, Part 1 alerts addressed and dismissed by the TTNs

TTN supports to ProACT Plus TTN Support PwMs by age group: Of the total of 430 phone calls made by the TTNs to the 32 ProACT Plus TTN Support PwMs between weeks 2 and 27, 215 were made to the 65-74 years age group (n=15), 177 to the 75-84 years age group (n=13) and 45 to the 85+ years age group (n=4) (Figure 30, page 170). The highest number of calls per week across the three age groups was 14 which occurred twice in weeks 2 and 17 in the 65-74 years age group. The lowest number of calls per week was one in the 85+ years age group which occurred on 13 occasions, and also in the 85+ years age group, no calls were made to PwMs on three occasions (weeks 13, 19 and 21).

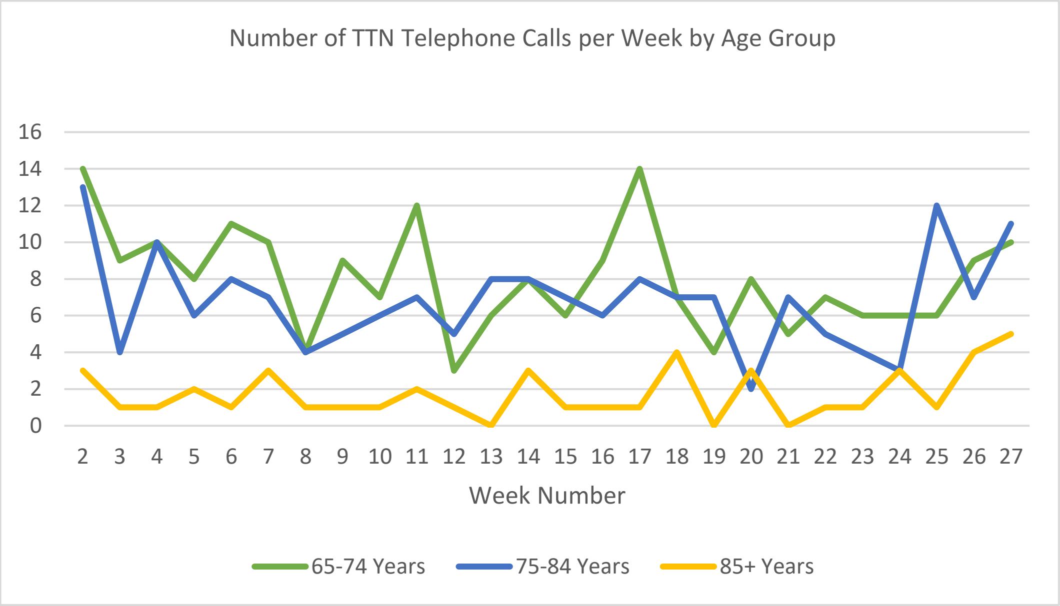


Figure 30: Study 2, Part 1 number of TTN telephone calls to PwMs per week by age group

Arising from the TTNs' phone calls to the 16 PwMs by age group, seven PwMs in the 65-74 years age group, seven in the 75-84 years age group and two in the 85+ years age group received referrals to the GP (Table 16 below). Further, one PwM in the 75-84 years age group received referrals to the GP and emergency care, while two PwMs in the 75-84 years age group received GP and other referrals.

Table 16: *Study 2, Part 1 referrals to other HCPs by age group*

Age Group	Number of PwMs who Received a Referral	Referral Type
65-74 Years	7	GP
75-84 Years	7	GP
85+ Years	2	GP
65-74 Years	0	Specialist
75-84 Years	0	Specialist
85+ Years	0	Specialist
65-74 Years	0	Emergency Care
75-84 Years	1	Emergency Care
85+ Years	0	Emergency Care
65-74 Years	0	Other
75-84 Years	2	Other
85+ Years	0	Other

The majority of alerts dealt with by the TTNs was for blood pressure for the 75-84 years age group (102 alerts addressed and 460 dismissed) (Table 17 below). The lowest number of alerts occurred for weight (alerts for which were monitored for participants with CHF) for the 85+ years age group (17), of which two were addressed and 15 dismissed. Meanwhile no alerts were recorded in the 85+ years age group for blood glucose and blood oxygenation as none of the four PwMs in this age group managed diabetes or a chronic respiratory condition.

Table 17: *Study 2, Part 1 alerts addressed and dismissed by the TTNs by age group*

Device Type	Number of Participants (n=32)	Alerts Addressed	Alerts Dismissed	Total Alerts
65-74 Years Blood Glucose Monitor	9	22	53	75
75-84 Years Blood Glucose Monitor	6	58	192	250
85+ Years Blood Glucose Monitor	0	0	0	0
65-74 Years Blood Pressure Monitor	18	79	356	435
75-84 Years Blood Pressure Monitor	12	102	460	562
85+ Years Blood Pressure Monitor	2	19	78	97
65-74 Years Pulse Oximeter	11	8	11	19
75-84 Years Pulse Oximeter	11	16	23	39
85+ Years Pulse Oximeter	0	0	0	0
65-74 Years Weighing Scales	18	14	82	96
75-84 Years Weighing Scales	12	4	31	35
85+ Years Weighing Scales	2	2	15	17
Totals	**N/A**	**324**	**1301**	**1625**

6.6 Chapter 6 summary of findings

This chapter presented the objective engagement data collected within the ProACT platform concerning the SEURO project PwMs' engagement with digital self-management. It also outlined data in relation to the TTN supports provided to the ProACT Plus TTN Support participants. The key findings are as follows:

ProACT platform engagement:

1. **Overall usage:** Engagement was slightly higher in ProACT Plus TTN Support (with TTN support) than ProACT No TTN Support (without support) – 75.22% vs 73.91% of days; and,
2. **Age differences:** The 85+ years age group showed the most variability in engagement – highest engagement in ProACT Plus TTN Support (87.25%) and lowest in ProACT No TTN Support (52.33%). The 75-84 years age group engaged more in both s cohorts the 65-74 years age group (85.31% vs 63.27% ProACT Plus TTN Support, 83.71% vs 72.23% ProACT No TTN Support).

Key insight: TTN support maintained higher engagement with ProACT among older adults, especially in the 75-84 years and 85+ years age groups.

Device usage:

1. **Overall vitals monitoring:** ProACT Plus TTN Support recorded more vitals measures than ProACT No TTN Support (7,545 vs 6,561), averaging 290.19 vs 252.35 measures per week; and,
2. **Age differences:** ProACT No TTN Support's 65-74 years age group recorded the most vitals measures (4,456), while ProACT No TTN Support's 85+ group recorded the least (418).

Key insight: TTN support appeared to encourage consistent health monitoring.

Engagement with the CareApp and its features:

1. **Overall usage of the CareApp and the vitals devices:** Engagement with the CareApp was higher in ProACT Plus TTN Support than ProACT No TTN Support (54.16% vs 46.10% days engaged), and also with the vitals devices (47.84% vs 43.63% days engaged);
2. **Age differences:** ProACT No TTN Support's 65-74 years was the only ProACT No TTN Support age group that engaged more with the CareApp than ProACT Plus TTN Support (51.50% vs 48.60 days engaged). ProACT Plus TTN Support's 75-84 years age group had the highest number of days engagement (70.38%) with the devices, while the lowest (8.75%) was in ProACT Plus TTN Support's 85+ years age group;
3. **Overall features section usage:**
    - ProACT Plus TTN Support interacted the most with the CareApp features. After the vitals section, the medication feature was interacted with the most (26.41% of days vs 19.09%), while the education feature was interacted with the least (3.50% vs 2.19%);
    - ProACT Plus TTN Support on average completed significantly more surveys than ProACT No TTN Support (82.38 vs 43.84); and,
    - ProACT Plus TTN Support set activity goals on a higher average number of weeks than ProACT No TTN Support (21.69 vs 21), conversely, ProACT No TTN Support met activity goals on a higher average number of weeks than ProACT Plus TTN Support (9 vs 6.38).

4. **Age differences:**
    - ProACT Plus TTN Support's 65-74 years age group engaged most with the medication feature (29.67% days engaged), and ProACT No TTN Support's 85+ years age group engaged the least (2.67% days engaged);
    - The lowest engagement was with the education feature in all three age groups with ProACT Plus TTN Support's 85+ years age group engaging the most (5.25% days engaged) and the 65-74 years age group engaging the least (1.68% days engaged);
    - ProACT Plus TTN Support's 75-84 years age group completed the highest and lowest average numbers of surveys (93.77 and 15.14) respectively; and,
    - ProACT No TTN Support's 75-84 years age group set and met activity goals on the lowest average number of weeks (14 and 10) respectively, while ProACT No TTN Support's 85+ years age group only participant set and met activity goals on the highest average number of weeks (26 and 23 respectively).

Key insight: The TTNs support appeared to foster engagement with the CareApp, its features and the vitals devices. Their support also fostered engagement with the majority of the features across the different age groups.

TTN supports to ProACT Plus TTN Support PwMs:

1. **Overall supports:**
    - The TTNs made a total of 430 phone calls to the 32 ProACT Plus TTN Support PwMs – 192 scheduled and 238 unscheduled;
    - Arising from these calls 37 referrals to other HCPs were made for 16 PwMs – 34 to a GP, one to emergency care and two for unspecified reasons;

  - 1,625 device alerts were dealt with, 324 were addressed and 1,301 dismissed; and,
  - The blood pressure monitor generated the most alerts (1,094) and the pulse oximeter the fewest (58).

2. **Supports by age group:**
    - Of the 430 phone calls, 215 were made to the 65-74 years age group, 177 to the 75-84 years age group, and 45 to the 85+ years age group;
    - Seven PwMs in the 65-74 years and 75-84 years age groups and two PwMs in the 85+ years age group received GP referrals. In the 75-84 years age group, one participant was referred to emergency care, while two PwMs received other referrals; and,
    - The most device alerts were from the blood pressure monitor in the 75-84 years age group (102 addressed, 460 dismissed). The fewest alerts came from the weighing scales in the 85+ years age group (17 total, with two addressed and 15 dismissed).

Key insight: A substantial amount of practical support was provided by the TTNs to the PwMs through phone calls, referrals to other HCPs and dealing with the vitals devices alerts.

The thesis continues with the presentation of the quantitative and qualitative findings from the second part of Study 2.

Chapter 7: Study 2 – Exploring Digital Self-Management Engagement Patterns of PwMs with and without TTN Support

Part 2

7.0 Introduction

This chapter presents the findings from research conducted with a sub-set (n=24) of the 64 participants that was described in Chapter Four, Section 4.3.1 and whose data were included in the objective engagement findings in Chapter Six, which comprised the first part of Study 2. This chapter is the second part of Study 2 and builds upon Part 1's findings by combining quantitative and qualitative approaches in order to better understand PwMs' engagement with ProACT and the supports that the TTNs provided to the participants in ProACT Plus TTN Support.

The chapter commences with presenting the demographic data from the sub-set of 24 PwMs followed by the presentation of the objective engagement findings pertaining to their usage of the ProACT CareApp and its features, their active engagement with the blood glucose monitor, blood pressure monitor, pulse oximeter and weighing scales, and activity goal setting. In addition, data relating to the TTNs' interactions with the PwMs, e.g., the number of alerts addressed and the number of telephone calls made by them is presented. As in Chapter Six, data were collected in Netwell Admin which was outlined in Chapter Four, Section 4.4.1. Similar to Chapter Six, the data also includes findings related to the age groups included in this study. This chapter concludes with the presentation of the qualitative findings from semi-structured interviews conducted with the 24 PwMs in which three main themes were identified: (i) prior experience with using DHT and perceptions of using ProACT; (ii) engagement with the ProACT CareApp and devices; and, (iii) the role of the TTNs in supporting engagement with ProACT. These findings are presented in turn below.

7.1 Demographics

24 PwMs participated, of whom 17 were male and seven were female. This gender imbalance occurred because more males than females had been recruited to the SEURO trial at the time of participant recruitment. See Table 18 on page 178 for a summary of the PwM participant demographics. As in Chapter Five, the participants will be identified similarly, with the addition of the trial cohort to which they belonged (i.e., ID, gender, age, inclusion conditions, trial cohort). The participants were split between two groups – ProACT Plus TTN Support and ProACT No TTN Support, with 12 PwMs in each group.

Table 18: *Demographic information Study 2, Part 2 PwM participants (n=24)*

	Overall	**ProACT Plus TTN Support**	**ProACT No TTN Support**
Age Range	67-89 Years	67-89 Years	68-87 Years
Mean	74.50 Years	75.33 Years	73.67 Years
Gender *N* (%):			
Male	17 (70.83)	9 (75.00)	8 (66.67)
Female	7 (29.17)	3 (25.00)	4 (33.30)
Highest Educational Level *N* (%):			
Some Primary/Primary	0 (0.00)	0 (0.00)	0 (0.00)
Secondary	14 (58.34)	6 (50.00)	8 (66.67)
Diploma/Cert	3 (12.50)	3 (25.00)	0 (0.00)
Primary Degree	2 (8.33)	1 (8.33)	1 (8.33)
Postgrad	3 (12.50)	2 (16.67)	1 (8.33)
None/Missing	2 (8.33)	0 (0.00)	2 (16.67)
Living Status *N* (%):			
Lives Alone	7 (29.17)	3 (25.00)	4 (33.33)
Lives with Others	15 (62.50)	9 (75.00)	6 (50.00)
None/Missing	2 (8.33)	0 (0.00)	2 (16.67)
Marital Status N (%):			
Married	14 (58.34)	9 (75.00)	5 (41.67)
Living with Partner	0 (0.00)	0 (0.00)	0 (0.00)
Widowed	4 (16.67)	1 (8.33)	3 (25.00)
Single (Never Married)	0 (0.00)	0 (0.00)	0 (0.00)
Separated	2 (8.33)	1 (8.33)	1 (8.33)
Divorced	2 (8.33)	1 (8.34)	1 (8.33)
None/Missing	2 (8.33)	0 (0.00)	2 (16.67)
Condition Profile *N* (%):			
CHD + T2D	1 (4.17)	0 (0.00)	1 (8.33)
CHD+ Resp.	1 (4.17)	1 (8.33)	0 (0.00)
CHF + CVD	3 (8.33)	3 (25.00)	0 (0.00)
CVD + T2D	9 (37.50)	3 (25.00)	6 (50.00)
CVD + Resp.	4 (20.83)	3 (25.00)	1 (8.33)
HTN + Resp.	2 (8.33)	1 (8.33)	1 (8.33)
T2D + Resp.	2 (8.33)	0 (0.00)	2 (16.67)
CHF + CVD + Resp.	1 (4.17)	1 (8.34)	0 (0.00)
CHF + HTN + T2D	1 (4.17)	0 (0.00)	1 (8.34)

7.2 PwMs’ overall engagement with ProACT

Any engagement by trial cohort: Across the ProACT platform, the findings reveal that on average the PwMs from ProACT Plus TTN Support used the platform, i.e., engaged with either a device or the CareApp, slightly more than those from ProACT No TTN Support during the 26-week period (week two to week 27) reported herein (Table 19, page 180 and Figure 31, page 181). On average the PwMs in ProACT Plus TTN Support engaged on 83.92% of days, while those in ProACT No TTN Support engaged on 78.67% of days. The highest level of interaction with the platform was 99% of days in ProACT Plus TTN Support and 98% of days in ProACT No TTN Support, while the lowest level was 54% of days in ProACT Plus TTN Support and 34% of days in ProACT No TTN Support.

Table 19 presents an overview of engagement per participant across ProACT Plus TTN Support and ProACT No TTN Support, outlining each participant's age range, conditions, devices used, the percentage of days they engaged with any part of the platform, the CareApp and its sections, as well as the total number of vitals measures each participant took over the course of the trial. As in Chapter 6, the total number of measures in Table 19 is inclusive of heart rate measures.

Table 19: *Study 2, Part 2 PwM participants' (n=24), devices, percentage of days' any engagement and engagement with the CareApp and its sections, total number of vitals measures*

					% of Days Engaged Weeks 2 to 27							No. Measures
ID	**Trial Cohort**	**Age Group**	**Conditions**	**Devices**	**Any Engagement**	**CareApp**	**Vitals**	**Activity**	**Self report**	**Education**	**Medication**	**Vitals**
SEP02	1	75-84	CHD + COPD + HTN	BPM, pulse ox., weight	96	82	82	25	20	12	29	901
SEP05	1	65-74	CHD + HTN + T2D	BGM, BPM, weight	70	47	38	41	12	10	40	461
SEP07	1	85+	CHD + HTN + T2D	BPM, weight	95	26	8	8	6	15	9	515
SEP09	1	75-84	CHD + COPD + HTN + T2D	BGM, BPM, pulse ox., weight	59	56	55	27	16	2	5	580
SEP10	1	65-74	CHD + HTN + T2D	BGM, BPM, weight	75	73	70	54	14	4	71	696
SEP12	1	85+	CHD + CHF + HTN	BPM, weight	93	7	3	2	2	1	3	214
SEP15	1	75-84	CHD + COPD + T2D	BGM, BPM, pulse ox., weight	93	93	93	0	16	0	93	879
SEP20	1	65-74	CHD + T2D	BGM, BPM, weight	54	30	27	7	4	1	4	338
SEP43	1	75-84	CHD + COPD + HTN	BPM, pulse ox., weight	99	98	96	86	95	4	24	686
SEP47	1	75-84	COPD + HTN + Resp.	BPM, pulse ox., weight	93	90	89	88	10	1	2	655
SEP55	1	65-74	CHF + HTN + Resp.	BPM, pulse ox., weight	96	81	81	0	1	1	2	625
SEP65	1	65-74	CHD + Resp.	BPM, pulse ox., weight	84	57	51	12	50	3	8	475
				Average % of days engaged	**83.92**	**61.67**	**57.75**	**29.17**	**20.50**	**4.50**	**24.17**	**Average: 585**
SEP01	2	65-74	CHD + HTN + T2D	BGM, BPM, weight	34	1	0	1	0	0	1	64
SEP08	2	65-74	CHD + T2D	BGM, BPM, weight	93	66	65	2	5	1	4	978
SEP11	2	65-74	Resp. + T2D	BGM, BPM, weight	93	93	93	1	64	1	60	545
SEP13	2	65-74	CHD + T2D	BGM, BPM, weight	84	58	46	7	6	0	2	471
SEP14	2	75-84	CHD + HTN + T2D	BGM, BPM, weight	80	73	69	3	17	7	11	614
SEP19	2	85+	CHD + T2D	BGM, BPM, weight	54	34	31	0	2	6	6	344
SEP23	2	65-74	HTN + T2D	BGM, BPM, weight	45	3	2	2	2	1	2	108
SEP26	2	65-74	CHD + COPD + T2D	BPM, pulse ox., weight	86	84	83	1	2	1	2	767
SEP32	2	75-84	HTN + T2D	BGM, BPM, weight	92	92	92	10	5	6	86	1161
SEP42	2	65-74	Resp. + T2D	BGM, BPM, pulse ox., weight	92	3	2	2	1	2	2	631
SEP46	2	75-84	CHF + HTN +T2D	BGM, BPM, weight	93	80	76	3	4	1	60	594
SEP48	2	65-74	COPD + HTN.	BPM, pulse ox., weight	98	98	97	7	33	3	81	1169
				Average % of days engaged	**78.67**	**57.08**	**54.67**	**3.25**	**11.75**	**2.42**	**26.42**	**Average: 621**

Legend: BGM = blood glucose monitor, BPM = blood pressure monitor, pulse ox. = pulse oximeter

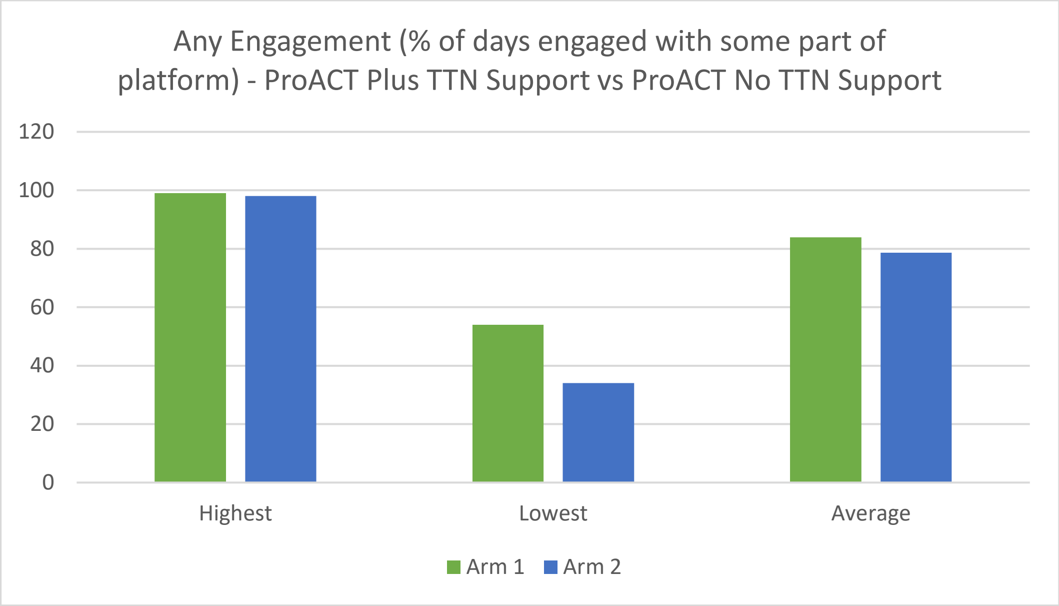


Figure 31: Study 2, Part 2 any engagement by trial cohort

Any engagement by trial cohort and age group: Across the platform, the two ProACT Plus TTN Support PwMs in the 85+ years age group had the highest average level of interaction (94% days engaged), while the one ProACT No TTN Support PwM in the same age group recorded the lowest average level (54% days engaged) (Figure 32, page 182). This was also the highest difference in engagement between the two cohorts' age groups, while the smallest difference was in the 75-84 years age group, with ProACT No TTN Support's 75-84 years group engaging slightly more than their ProACT Plus TTN Support counterparts (88.33% vs 88% days engaged). Meanwhile, ProACT No TTN Support's 65-74 years age group also engaged more than their ProACT Plus TTN Support counterparts (78.13% vs 75.80% days engaged).

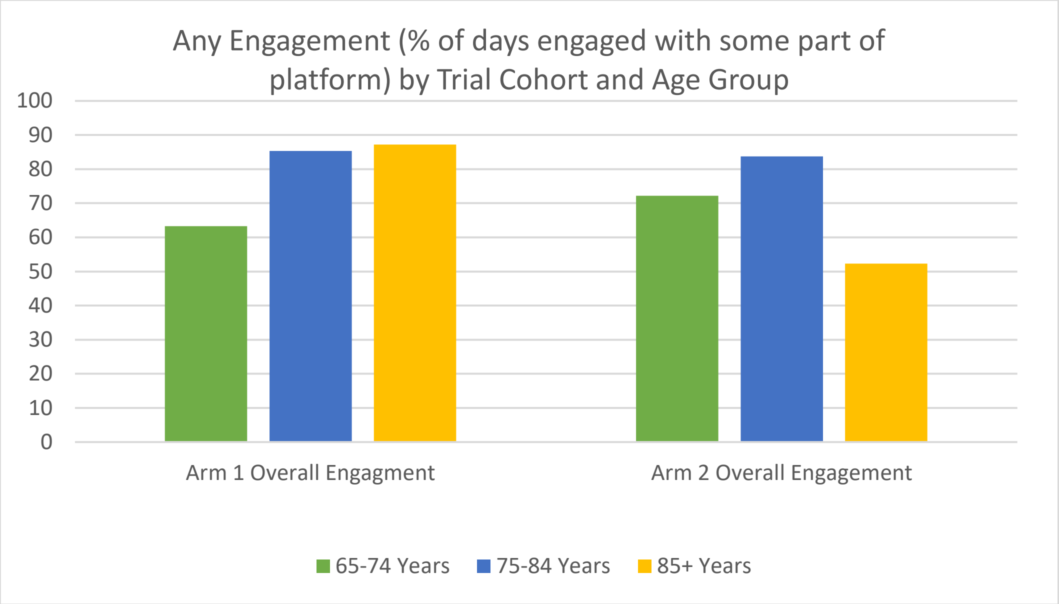


Figure 32: Study 2, Part 2 any engagement by trial cohort and age group

7.3 Engagement with health monitoring devices

The number of vitals measures taken by trial cohort: When looking at the numbers of measures taken with the devices, of the total number of 6,043 measures taken, overall, ProACT Plus TTN Support took more measures than ProACT No TTN Support (3,328 vs 2,715) (Table 20, page 183). This was also the case with all devices apart from the blood glucometer with ProACT No TTN Support taking more measures than ProACT Plus TTN Support (554 vs 368), which is to be expected as 11 of the 12 ProACT No TTN Support participants had diabetes while only five ProACT Plus TTN Support participants did. When this is taken into account, the average number of blood glucose measures taken per participant in ProACT Plus TTN Support is 73.60, while the average number taken per participant in ProACT No TTN Support is 50.40. The average number of blood pressure measures taken per participant in ProACT Plus TTN Support is 89.00 while the average number taken per participant in ProACT No Support is 79.33. Similarly, more PwMs in ProACT Plus TTN Support had a respiratory condition than those in ProACT No TTN Support (six vs four). The average number of pulse oximeter measures taken per participant in ProACT Plus TTN Support is 117.67, and in ProACT No TTN Support is 77.50. The average number of weighing scales measures taken per participant by ProACT Plus TTN Support is 99.08, and by ProACT No TTN Support is 74.92. Further, ProACT Plus TTN Support took a higher average number of measures per week from week 2 to week 27 than ProACT No TTN Support (128 vs 104.42), with the total average number of measures taken per week being 232.42.

Table 20: *Study 2, Part 2 number of measures taken by trial cohort*

Trial Cohort	Blood Glucometer	Ave. No. of Measures per PwM	Blood Pressure Monitor	Ave. No. of Measures per PwM	Pulse Oximeter	Ave. No. of Measures per PwM	Weighing Scales	Ave. No. of Measures per PwM	Totals	Ave. No. of Measures per Week
ProACT Plus TTN Support	368 (n=5)	73.60	1068 (n=12)	89.00	703 (n=6)	117.17	1189 (n=12)	99.08	**3328**	**128**
ProACT No TTN Support	554 (n=11)	50.40	952 (n=12)	79.33	310 (n=4)	77.50	899 (n=12)	74.92	**2715**	**104.42**
Totals	**922**	**124**	**2020**	**168.33**	**1013**	**194.67**	**1973**	**174**	**6043**	**232.42**

The number of vitals measures taken by trial cohort and age group: Within ProACT Plus TTN Support, there were five PwMs in the 65-74 years age group, five in the 75-84 years age group and two in the 85+ years age group, while in ProACT No TTN Support there were eight PwMs in the 65-74 years age group, three in the 75-84 years age group and one in the 85+ years age group. The highest total number of measures was taken by ProACT No TTN Support's 65-74 years age group (1,711), while the lowest total number taken was 134 by ProACT No TTN Support's 85+ age group (Figure 33, page 185).

In ProACT Plus TTN Support, the number of PwMs in the 65-74 years age group using a blood glucometer was three and using a pulse oximeter was two. In the 75-84 years age group the number of PwMs using a blood glucometer was two and using a pulse oximeter was five. In the 85+ years age group neither PwM had diabetes or a respiratory condition and therefore did not use a blood glucometer or pulse oximeter. In ProACT No TTN Support, the number of PwMs in the 65-74 years age group using a blood glucometer was seven and using a pulse oximeter was four. In the 75-84 years age group the number of PwMs using a blood glucometer was three, while none had a respiratory condition and therefore did not use a pulse oximeter. The one PwM in the 85+ years age group used a blood glucometer but did not use a pulse oximeter as they did not have a respiratory condition. By device, ProACT No TTN Support's 65-74 years age group also took the highest number of measures (566) which were with the weighing scales, while the lowest number of measures taken was by ProACT No TTN Support's 85+ years age group which were taken with the blood pressure monitor (64). Meanwhile, no measures were taken with the blood glucose monitor by the 85+ age group, despite one PwM in this age group in ProACT No TTN Support having diabetes and access to a blood glucometer. The highest average number of measures taken per week from week 2 to week 27 was 65.81 by ProACT No TTN Support's 65-74 years age group, while the lowest average number taken was 5.15 by ProACT No TTN Support's 85+ years age group.

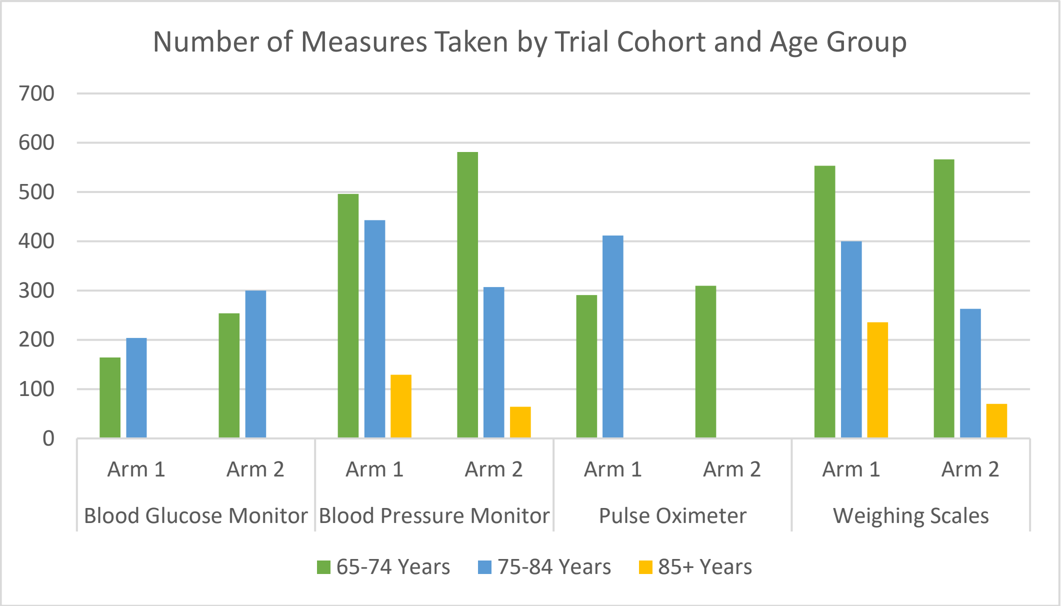


Figure 33: Study 2, Part 2 number of measures taken by trial cohort and age group

7.4 Engagement with the CareApp and its features:

The CareApp by trial cohort: Overall engagement with the CareApp was slightly higher in ProACT Plus TTN Support (61.67% days engaged) than in ProACT No TTN Support (57.08% days engaged) (Table 19, page 180 and Figure 34, page 186). In investigating the engagement with the vitals section of the CareApp, this occurred on 57.75% of days for the ProACT Plus TTN Support PwMs, which was a slightly higher level of engagement than that of ProACT No TTN Support's PwMs which was 54.67% of days engaged.

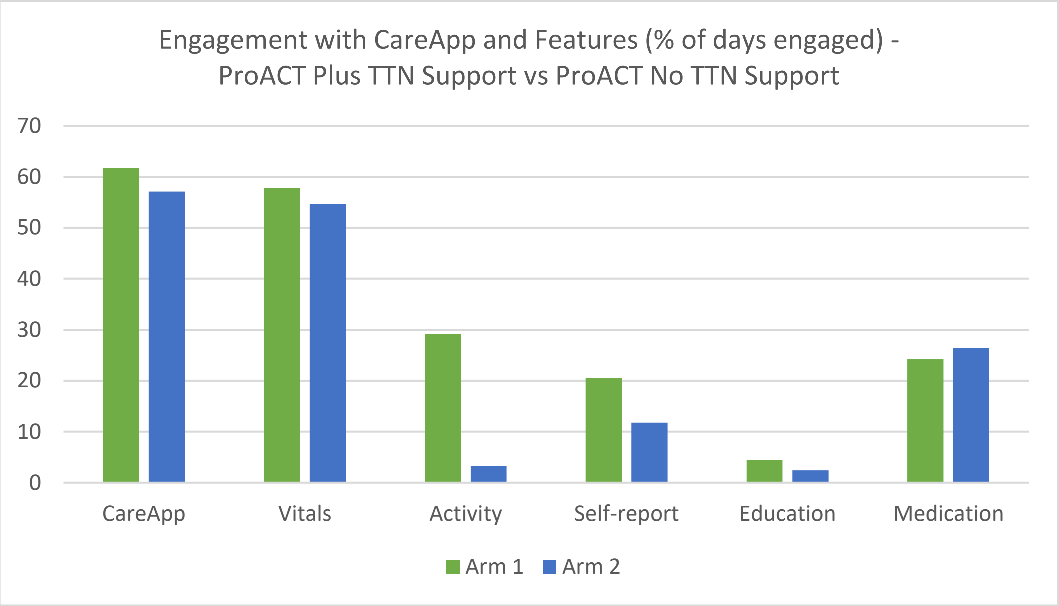


Figure 34: Study 2, Part 2 engagement with the CareApp and features by trial cohort

As can be further seen from Table 19 and Figure 34, the most engagement with the activity, self-report and education features came from ProACT Plus TTN Support (29.17% of days, 20.50% of days and 4.50% of days respectively), while ProACT No TTN Support's engagement with the same features was 3.25% of days, 11.75% of days and 2.42% of days respectively. Finally, ProACT No TTN Support's engagement with the medication feature was slightly higher than ProACT Plus TTN Support's (26.42% vs 24.17% days engaged).

When examining the number of self-report surveys completed, ProACT Plus TTN Support completed 1,353, while ProACT No TTN Support completed 863 (Table 21, page 187). On average, ProACT Plus TTN Support PwMs completed 112.75 surveys and ProACT No TTN Support completed 71.83. Meanwhile, the average number of surveys completed each week was 8.17 for ProACT Plus TTN Support and 4.58 for ProACT No TTN Support. In each cohort, four PwMs never completed a self-report survey.

Table 21: *Study 2, Part 2 number of self-report surveys completed by trial cohort*

Trial Cohort	Number of Self-report Surveys Completed	Average Number of Self-report Surveys Completed	Average Number of Self-report Surveys Completed Each Week	Number of Participants who Did Not Complete Self-report Surveys
ProACT Plus TTN Support	1353	112.75	8.17	4
ProACT No TTN Support	862	71.83	4.58	4

***Activity goal setting by trial cohort*:** A total of nine PwMs set an activity goal, five in ProACT Plus TTN Support and four in ProACT No TTN Support (Figure 35 below). Of these PwMs, the number of goals set by ProACT Plus TTN Support was 12 and by ProACT No TTN Support it was five. Further, for ProACT Plus TTN Support, the average number of weeks a goal was set was 23, with the average number of weeks a goal was met being 9.20, while for ProACT No TTN Support, a goal was set an average of 21 weeks and met an average of 11.50 weeks.

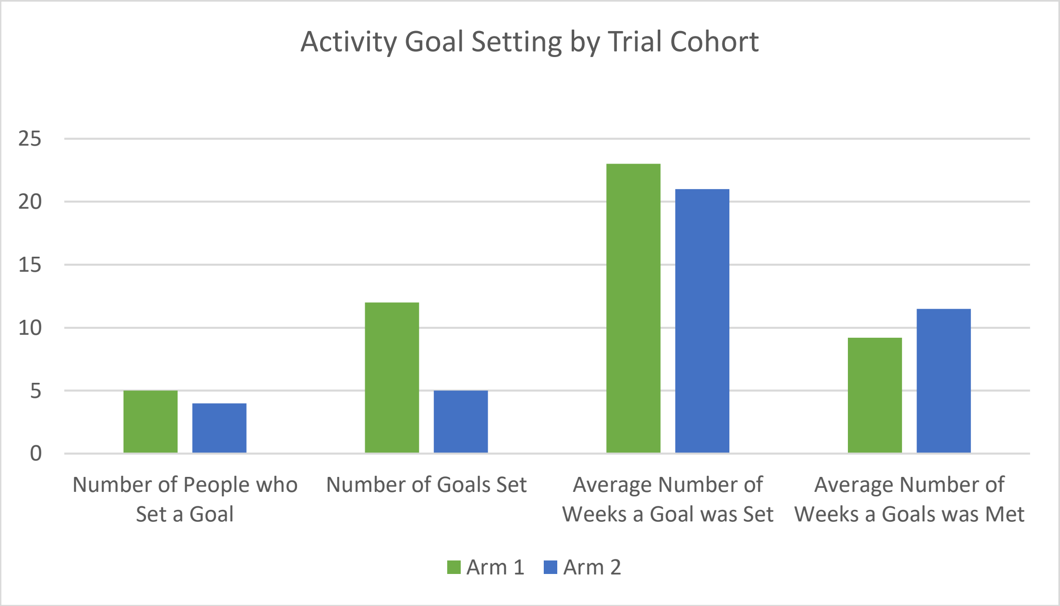


Figure 35: Study 2, Part 2 activity goal setting by trial cohort

***The CareApp by trial cohort and age group*:** ProACT Plus TTN Support's 75-84 years age group engaged most with the CareApp (83.80% days engaged), while ProACT Plus TTN Support's 85+ years age group engaged the least (16.50% days engaged) (Table 22 and Figure 36, page 189). Further, the age group with the smallest difference in CareApp engagement between the cohorts was in the 75-84 years age group with ProACT Plus TTN Support being engaged on 83.80% of days and ProACT No TTN Support being engaged on 81.66% of days (Table 22, page 189 and Figure 37, page 190). There was also a small difference in engagement levels between the two 65-74 years age groups (ProACT Plus TTN Support=57.60% vs ProACT No TTN Support=50.75% days engaged). Finally, the largest difference in engagement levels between the cohorts was in the 85+ years age group. The ProACT No TTN Support PwMs had the higher level of engagement with the CareApp (34% days engaged) compared to ProACT Plus TTN Support's PwMs who engaged on 16.50% of days.

Table 22: *Study 2, Part 2 ProACT Plus TTN Support and ProACT No TTN Support PwMs' (n=24) percentage of days engagement with the CareApp and its features by trial cohort and age group*

		% of Days Engaged Weeks 2 to 27					
Trial Cohort and Age Group	**Number of Participants**	**CareApp**	**Vitals**	**Activity**	**Self-report**	**Education**	**Medication**
ProACT Plus TTN Support 65-74 Years	5	57.60	53.40	22.80	16.20	3.60	25.00
ProACT No TTN Support 65-74 Years	8	50.75	48.50	2.88	14.13	1.13	19.25
ProACT Plus TTN Support 75-84 Years	5	83.80	83.00	45.20	31.40	3.80	30.60
ProACT No TTN Support 75-84 Years	3	81.66	79.00	5.33	8.67	4.67	52.33
ProACT Plus TTN Support 85+ Years	2	16.50	5.50	5.00	5.50	8.00	6.00
ProACT No TTN Support 85+ Years	1	34.00	31.00	0	2.00	6.00	6.00

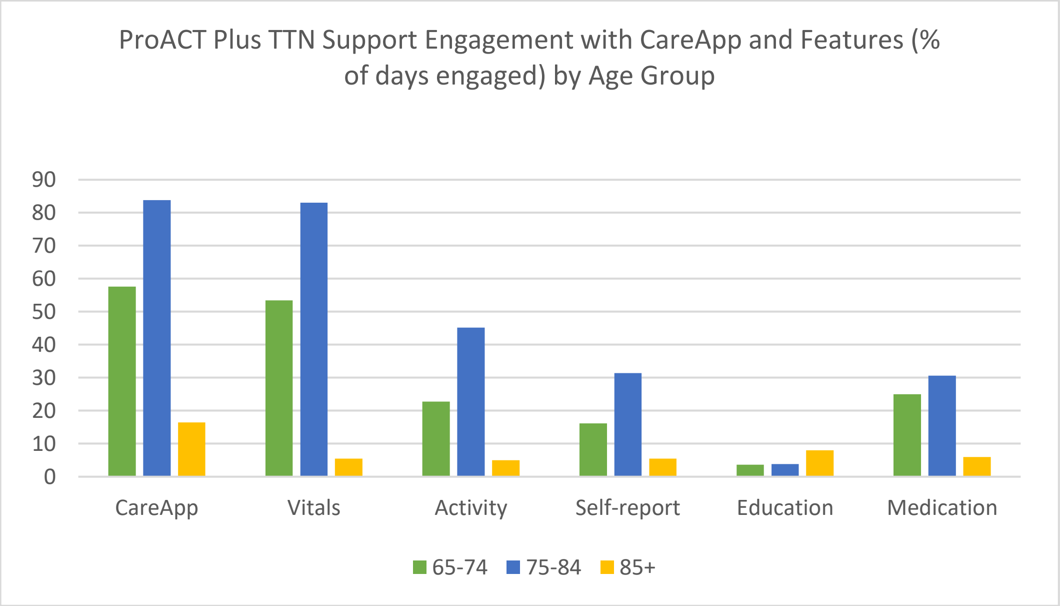


Figure 36: Study 2, Part 2 ProACT Plus TTN Support engagement with the CareApp and features by age group

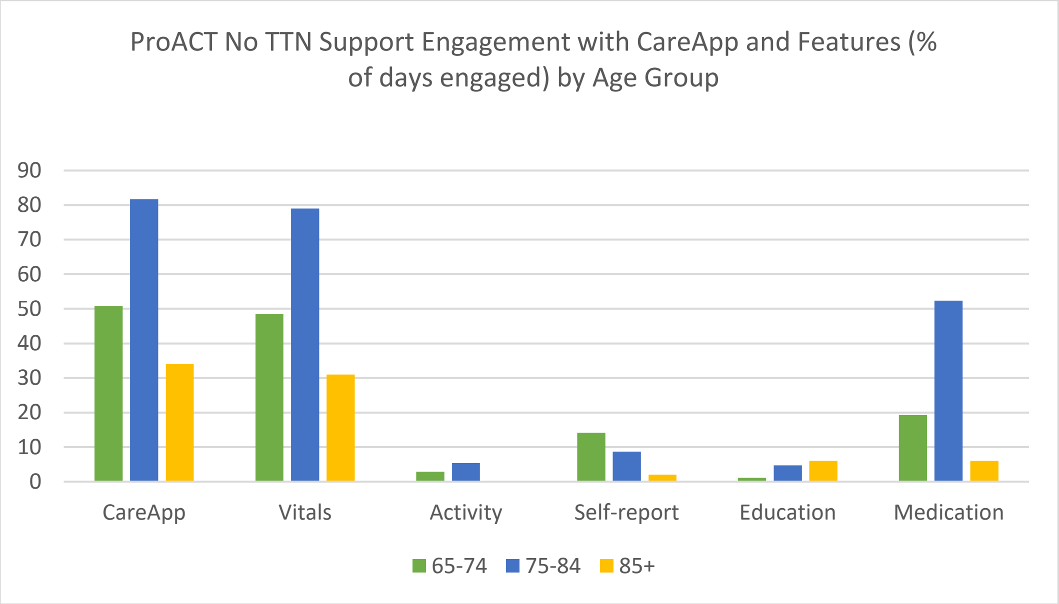


Figure 37: Study 2, Part 2 ProACT No TTN Support engagement with the CareApp and features by age group

ProACT Plus TTN Support's 75-84 years age group recorded the highest usage of the vitals section of the CareApp, visiting this section on 83.80% of days, which was slightly higher than their ProACT No TTN Support counterparts who recorded engagement on 79% of days (Table 22 and Figures 36 and 37). The lowest level of engagement with this section of the CareApp came from the 85+ years age group, with ProACT Plus TTN Support's participants using it least of all (5.50% of days engagement), followed by ProACT No TTN Support's participants who used it on 31% of days.

Across the three categories and six age groups, the highest level of engagement was with the medication feature in ProACT No TTN Support's 75-84 years age group (52.33% days engaged). The medication feature was also the most used feature for the 65-74 years age group in both trial cohorts (ProACT Plus TTN Support=25% vs ProACT No TTN Support=19.25% days engaged). The lowest level of engagement across age groups and features was with the education feature in ProACT No TTN Support's 65-74 years age group (1.13% days engaged) and it was also the least engaged with feature for ProACT Plus TTN Support's 65-74 years age group (3.60% days engaged) and both cohorts' 75-84 years age groups (ProACT Plus TTN Support=3.80% vs ProACT No TTN Support=4.67% days engaged). For the 85+ years age group, they engaged least with the self-report feature (5.50% days engaged in ProACT Plus TTN Support and 2% days engaged in ProACT No TTN Support).

In examining the number of self-report surveys completed, the highest number completed was 827 in ProACT Plus TTN Support's 75-84 years age group, while ProACT Plus TTN Support's 85+ years age group completed the lowest number (one) (Table 23 below). ProACT Plus TTN Support's 65-74 years age group completed the highest average number of surveys (171.40), while the lowest average number completed was by ProACT Plus TTN Support's 85+ years age group (0.50). The highest average number of surveys completed each week was by ProACT Plus TTN Support's 75-84 years age group (5.20), while ProACT No TTN Support's 75-84 years age group completed the lowest average number (1.33). Meanwhile, no surveys were completed by the 85+ years age group. Further, all age groups across both trial cohorts apart from ProACT No TTN Support's 75-84 years age group had PwMs who completed no surveys, and of these, ProACT No TTN Support's 65-74 years age group had the highest number of PwMs (three) who did not complete a survey.

Table 23: *Study 2, Part 2 number of self-report surveys completed by trial cohort and age group*

Trial Cohort	Number of Participants	Number of Self-report Surveys Completed	Average Number of Self-report Surveys Completed	Average Number of Self-report Surveys Completed Each Week	Number of Participants who Did Not Complete Self-report Surveys
ProACT Plus TTN Support 65-74 Years	5	525	171.40	4.00	2
ProACT No TTN Support 65-74 Years	8	775	96.88	3.75	3
ProACT Plus TTN Support 75-84 Years	5	827	165.40	5.20	1
ProACT No TTN Support 75-84 Years	3	87	29.00	1.33	0
ProACT Plus TTN Support 85+ Years	2	1	0.50	0.00	1
ProACT No TTN Support 85+ Years	1	0	0.00	0.00	1

***Activity goal setting by trial cohort and age group*:** Of the nine PwMs who set an activity goal, the number who set an activity goal in the 65-74 years age group was six, in the 75-84 years age group it was two, and in the 85+ years group it was one, while the other participant in this age group did not set a goal (Table 24 below and Figure 38, page 193). The 65-74 years age group PwMs set the most goals (12), and ProACT Plus TTN Support set the majority of these (nine). The highest average number of weeks a goal was set per was 26 by ProACT Plus TTN Support's 85+ years age group, and the lowest average number of weeks was 20 which was set by both cohorts from the 75-84 years age group. Finally, the highest average number of weeks a goal was met was 20 by the PwM from ProACT Plus TTN Support's 75-84 years age group and the lowest average number one was met was 2.67 by ProACT No TTN Support's 65-74 years age group.

Table 24: *Study 2, Part 2 activity goal setting by trial cohort and age group*

Trial Cohort and Age Group	Number of Participants	Number of People who Set a Goal	Number of Goals Set	Average Number of Weeks a Goal was Set	Average Number of Weeks a Goals was Met
ProACT Plus TTN Support 65-74 Years	5	3	9	23.00	6.67
ProACT No TTN Support 65-74 Years	8	3	3	21.33	2.67
ProACT Plus TTN Support 75-84 Years	5	1	2	20.00	20.00
ProACT No TTN Support 75-84 Years	3	1	2	20.00	16.00
ProACT Plus TTN Support 85+ Years	2	1	1	26.00	6.00
ProACT No TTN Support 85+ Years	1	0	0	0.00	0.00

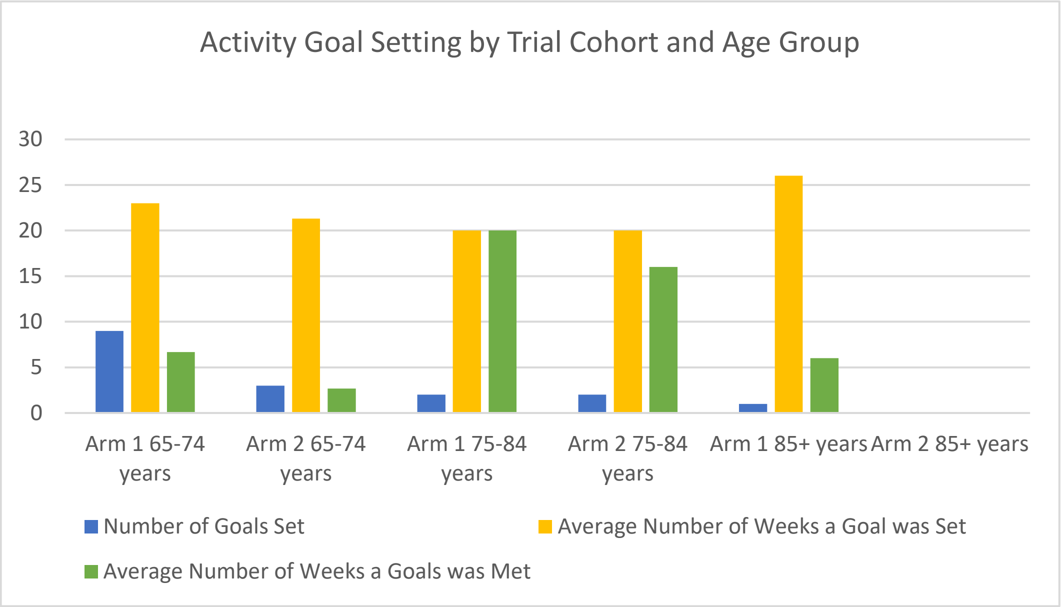


Figure 38: Study 2, Part 2 activity goal setting by trial cohort and age group

7.5 TTN supports to ProACT Plus TTN Support PwMs

TTN supports to ProACT Plus TTN Support PwMs overall: Over the 26 weeks of the trial, a total of 147 phone calls were made by the TTNs to the 12 ProACT Plus TTN Support PwMs (Figure 39 page 194). Of these phone calls, 72 were scheduled as each PwM received six scheduled phone calls during their time on the trial. The highest number of calls per week was made in week two (10), while the lowest number of calls (one) was made in week eight.

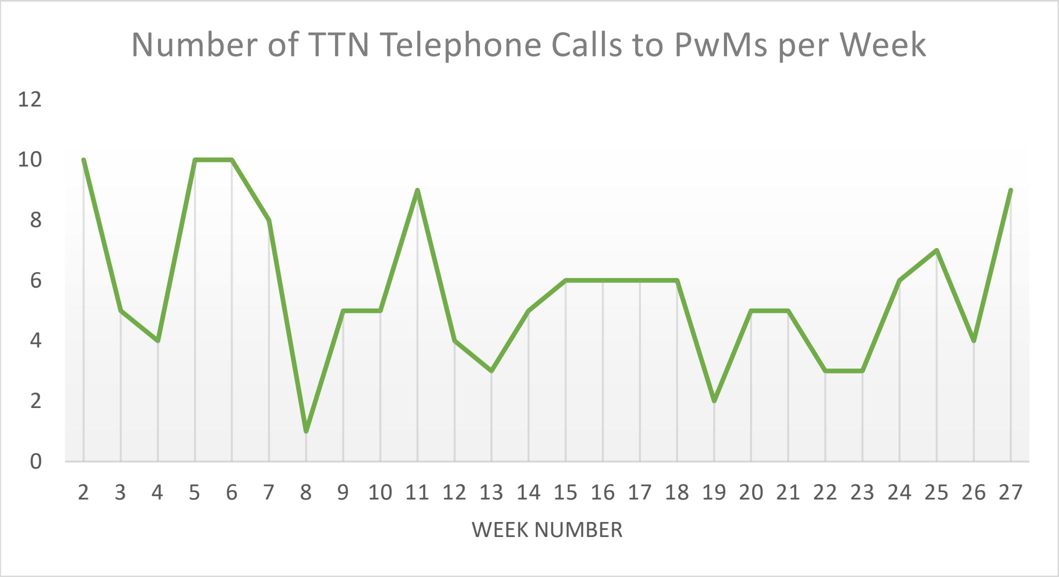


Figure 39: Study 2, Part 2 number of TTN telephone calls to PwMs per week

Arising from these calls, seven PwMs received 18 referrals in total from the TTNs to other HCPs (Table 25 below). 17 of these referrals were made for the GP and one was unspecified. No referrals were made to the specialist or emergency care. One PwM received eight GP referrals and one referral which was unspecified.

Table 25: *Study 2, Part 2 referrals to other HCPs*

Referral Type	Number
GP	17
Specialist	0
Emergency Care	0
Other	1

In total, the TTNs dealt with 563 alerts, the majority (473) were dismissed, while 90 were addressed (Table 26, page 195). The blood pressure monitor caused the largest number of alerts (428), while the pulse oximeter caused the smallest number (27).

Table 26: *Study 2, Part 2 alerts addressed and dismissed by the TTNs*

Device Type	Number of Participants (n=12)	Alerts Addressed	Alerts Dismissed	Total Alerts
Blood Glucose Monitor	5	8	38	46
Blood Pressure Monitor	12	68	360	428
Pulse Oximeter	7	10	17	27
Weighing Scales	12	4	58	62
Totals	**N/A**	**90**	**473**	**563**

***TTN supports to ProACT Plus TTN Support PwMs by age group*:** Of the 147 phone calls made to the 12 ProACT Plus TTN Support PwMs during their 26 weeks on the trial, 83 were made to the 65-74 years group, 40 to the 75-84 years group and 24 to the 85+ years group (Figure 40 below). The highest number of calls made to the three age groups was seven which was in week six to the 65-74 years age group. In weeks eight and 12 this age group received no TTN calls, in five weeks (three, nine, 14, 20 and 23) the 75-84 age group received none, and finally, in nine weeks the 85+ age group also received none (weeks four, eight, 10, 12, 13, 16, 17, 19 and 21).

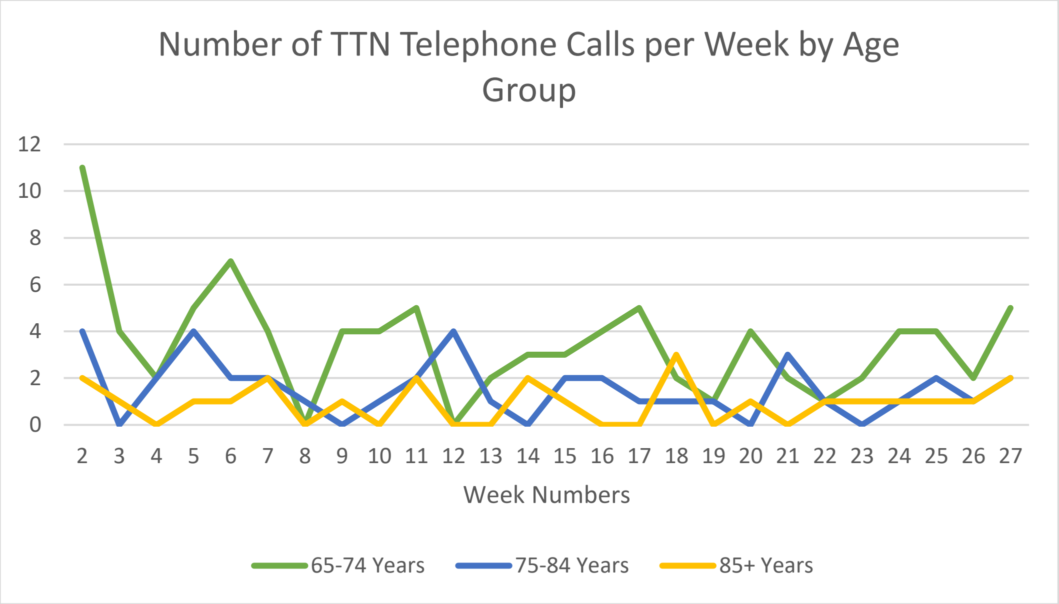


Figure 40: Study 2, Part 2 number of TTN telephone calls to PwMs per week by age group

In examining the 18 referrals to other HCPs made by the TTNs, all but one were made to the GP. In the 65-74 years age group, two were made for the GP, in the 75-84 years group 11 were made for the GP and the one referral which was unspecified, and for the 85+ years age group four were made for the GP (Table 27 below).

Table 27: *Study2, Part 2 referrals to other HCPs by age group*

Age Group	Referral Type	Number
65-74 Years	GP	2
75-84 Years	GP	11
85+ Years	GP	4
65-74 Years	Specialist	0
75-84 Years	Specialist	0
85+ Years	Specialist	0
65-74 Years	Emergency Care	0
75-84 Years	Emergency Care	0
85+ Years	Emergency Care	0
65-74 Years	Other	1
75-84 Years	Other	
85+ Years	Other	0

Of the 563 alerts dealt with by the TTNs, blood pressure in the 75-84 years age group caused the highest number (196) of which 27 were addressed and 169 dismissed, while the lowest number related to blood glucose in the 65-74 years age group (three) two of which were addressed and one dismissed (Table 28, page 197).

Table 28: *Study 2, Part 2 alerts addressed and dismissed by the TTNs by age group*

Device Type	Number of Participants (n=12)	Alerts Addressed	Alerts Dismissed	Total Alerts
65-74 Years Blood Glucose Monitor	3	2	1	3
75-84 Years Blood Glucose Monitor	2	6	37	43
85+ Years Blood Glucose Monitor	0	0	0	0
65-74 Years Blood Pressure Monitor	5	32	162	194
75-84 Years Blood Pressure Monitor	5	27	169	196
85+ Years Blood Pressure Monitor	2	9	29	38
65-74 Years Pulse Oximeter	2	1	3	4
75-84 Years Pulse Oximeter	4	9	14	23
85+ Years Pulse Oximeter	0	0	0	0
65-74 Years Weighing Scales	5	1	23	24
75-84 Years Weighing Scales	5	2	21	23
85+ Years Weighing Scales	2	1	14	15
Totals	**N/A**	**90**	**473**	**563**

This chapter continues with the presentation of findings from the semi-structured interviews that were conducted with the 24 participants from cohorts 1 and 2, beginning with the first theme which was ‘prior experience with using DHT and perceptions of using ProACT’. Table 29 on page 198 provides an overview of the three themes and various sub-themes that were constructed from the data.

Table 29: *Themes and sub-themes for Study 2, part 2*

Theme No.	Main Themes	Section No.	Sub-themes	Sub-section No.
1.	Prior experience with using DHT and perceptions of using ProACT	7.6	1. Experiences of using technology prior to the SEURO trial 2. Perceptions of using ProACT for self-management (i) The readings and reminders 3. Issues with ProACT	7.6.1 7.6.2 7.6.2.1 7.6.3
2.	Engagement with the ProACT CareApp and devices	7.7	1. Using ProACT (i) Taking and looking at the readings (ii) Using the CareApp features (iii) Perceived changes in engagement levels 2. Motivation to use ProACT and engage in self-management behaviours	7.7.1 7.7.1.1 7.7.1.2 7.7.1.3 7.7.2
3.	The role of the TTNs in supporting engagement with ProACT	7.8	1. The TTNs' support 2. The nature of the PwMs' relationship with the TTNs 3. The TTNs' influence on engagement levels with ProACT 4. Self-management without the TTNs	7.8.1 7.8.2 7.8.3 7.8.4

7. 6 Theme one – prior experience with using DHT and experience of using ProACT

In this theme three sub-themes were constructed: (i) experiences of using technology prior to the SEURO trial; (ii) perceptions of using ProACT for self-management; and, (iii) issues with ProACT. These will be discussed in turn below.

7.6.1 Experiences of using technology prior to the SEURO trial

The PwMs in both trial cohorts had been proactively self-managing their health through a combination of visiting their GPs, attending clinics, keeping their own records of blood pressure, blood glucose levels and weight for example. Only one ProACT Plus TTN Support participant spoke about not being as aware of his conditions before participating in SEURO as he was once he joined the trial. Otherwise, the PwMs perceived that they had been coping well with managing their conditions. The PwMs were then asked about their experience with using technology and DHT before participating in SEURO, and the majority (15) across both trial cohorts (ProACT Plus TTN Support=7, ProACT No TTN Support=8) reported that they had used it previously. For instance, five PwMs (ProACT Plus TTN Support=3, ProACT No TTN Support=2) owned tablets (including iPads), one ProACT Plus TTN Support participant owned an iPhone, while the use of devices to monitor conditions such as blood pressure monitors, pulse oximeters and blood glucose monitors was also reported. However, this was on an infrequent basis for nine (ProACT Plus TTN Support=5, ProACT No TTN Support=4) of those who had been monitoring their health, for example: "*I occasionally used to take my blood pressure. That was on an old meter I had*" (SEP08, M, 73, CHD + T2D, ProACT No TTN Support). Of the remaining nine PwMs (ProACT Plus TTN Support=4, ProACT No TTN Support=5) who were not using DHT prior to SEURO, two ProACT Plus TTN Support participants reported that they relied on their HCPs to monitor their symptoms, while another had been taking readings in the past but stopped when his symptoms stabilised: "*I did use one [blood glucose monitor] for a while when I got diabetes. I did have one until it came under control*" (SEP20, M, 72, CHD + T2D, ProACT Plus TTN Support). When asked if they had had help with using their devices before participating in SEURO, six PwMs (ProACT Plus TTN Support=3, ProACT No TTN Support=3) had received help from family members, friends or clinic nurses. The nine (ProACT Plus TTN Support=5, ProACT No TTN Support=4) other PwMs who had used technology previously reported that they knew how to use the technology themselves, so they did not need help with it, for instance: "*But normally the stuff you get with this thing [the iPad], it's self-explanatory and it's not, it's not rocket science as such in a lot of it*" (SEP20, M, 72, CHD + T2D, ProACT Plus TTN Support).

7.6.2 Perceptions of using ProACT for self-management

When discussing their perceptions of using the ProACT platform, the majority (22) of PwMs across both trial cohorts (ProACT Plus TTN Support=11, ProACT No TTN Support=11) were positive about their general experiences with it. Eight PwMs (ProACT Plus TTN Support=6, ProACT No TTN Support=2) spoke about the platform's usability, reporting that they found it easy to use, whether or not they had previous experience of using any form of technology for self-managing their health. For instance: "*I think that the monitoring that the way they've made it so simple to do is fantastic…and they have made it as easy I find as operating a TV remote*" (SEP20, M, 72, CHD + T2D, ProACT Plus TTN Support). This was echoed by other PwMs who felt that ProACT was 'self-explanatory' which meant that it required little effort to use, and in addition, some PwMs reported that they were able to troubleshoot issues they had with it. SEP08 (M, 73, CHD + T2D, ProACT No TTN Support) reported that he found the CareApp straightforward to use and was able to find the information he needed within it 'reasonably quickly'. Another PwM, SEP42 (M, 71, Resp. + T2D, ProACT No TTN Support), stated that he found it to be an improvement on using his smart phone: "*I was so used to doing things on the smart phone…but I find it now that with the tablet everything is a bit bigger so it's easier*" (SEP42, M, 71, Resp. + T2D, ProACT No TTN Support).

However, despite the positive perceptions of the ProACT platform generally, nevertheless, when asked specific questions about it, one third of the PwMs (eight) expressed negative opinions with aspects of it (ProACT Plus TTN Support=5, ProACT No TTN Support=3). For example, two PwMs (one from each trial cohort) spoke about the 'nuisance' and 'chore' of having to take their readings, and about the trial being 'repetitive' and 'tedious' because their readings remained constant from day-to-day. Another ProACT Plus TTN Support PwM discussed 'being tied' to the iPad and devices, while two other ProACT Plus TTN Support PwMs felt that ProACT could cause needless worry and stress to people if they started to take their readings too frequently. For instance, SEP12 (M, 85, CHD + CHF + HTN., ProACT Plus TTN Support) discussed the possibility that having ProACT would make people anxious, and he was wary of becoming obsessed with taking his readings:

> *The other thing I should say about the technology or software, it would be one of the things that I feel could generate obsession and anxiety you know and I don't want to go down that road, I'm happy enough doing what I'm doing and I think I'm on top of things* (SEP12, M, 85, CHD + CHF + HTN, ProACT Plus TTN Support)

The issue of a third party (i.e., the research team) having access to his health data was raised by one of the PwMs (SEP01, M, 71, CHD + HTN + T2D, ProACT No TTN Support), who had discussed his participation in the trial with one of his HCPs. The HCP voiced their concern with him about this, which consequently made the PwM concerned about the issue. Finally, a fear of using the CareApp and devices was discussed by two PwMs in ProACT No TTN Support. They spoke about being fearful in case they did something wrong, for instance: "*I'm half afraid in case I delete something by mistake or knock something off*" (SEP13, F, 68, CHD + T2D, ProACT No TTN Support). This was echoed by the second PwM: "*I'll break the thing or blow it up or something or ruin it or something you know by pressing the wrong buttons*" (SEP23, M, 70, HTN + T2D, ProACT No TTN Support). Nobody from ProACT Plus TTN Support mentioned having a fear of using any part of ProACT.

7.6.2.1 The readings and reminders

17 of the PwMs across both trial cohorts (ProACT Plus TTN Support=8, ProACT No TTN Support=9) perceived that taking their readings regularly meant that they knew their health statuses which they felt was very important as it enabled them to focus on what they needed to do to look after their health, rather than wait to be told what to do by their GP. It also gave

them a sense of security and allowed them to make tweaks to their self-management if a reading was outside their normal range: "*Ah well look, if it goes very high or very low or anything like that, it keeps me aware to change what I'm doing or have done, say the previous day*" (SEP14, M, 79, CHD + HTN + T2D, ProACT No TTN Support). For SEP48 (71, COPD + HTN, ProACT No TTN Support), she preferred to have her readings and know her health status because it gave her a sense of control. She had recently experienced a health crisis which led to her hospitalisation where she had a bad experience with one of the nurses caring for her. She perceived that the nurse had been uncooperative when she requested to see a doctor, which left her feeling vulnerable because she did not know what was happening to her and wished to speak to a doctor to ease her concerns.

Other PwMs (ProACT Plus TTN Support=6, ProACT No TTN Support=10) spoke about being able to discuss their readings with their GP either when they were able to get an appointment or on the telephone, which helped to allay any concerns they had: "*I'll ring my doctor about my blood pressure because it's one, 145 and it goes up to 152, I'm kind of a bit worried, and I find it's great for that now*" (SEP48, F, 71, COPD + HTN, ProACT No TTN Support). One PwM (SEP10, M, 68, CHD + HTN + T2D, ProACT Plus TTN Support), spoke about the benefit of having the devices for taking his readings as he could monitor his own health when he was not able to visit his GP and felt that it was a good substitute. For SEP20 (M, 72, CHD + T2D, ProACT Plus TTN Support), having the devices to measure his blood pressure meant that he did not need to visit his GP:

> *Well, it's to do with the fact that I think it, I think it's great that this monitor that you can get, you can get your health monitored and you monitor it yourself without tormenting your GP. So, this is a way of monitoring I think it helps you to be more relaxed that that you see that the readings are OK*
> (SEP20, M, 72, CHD + T2D, ProACT Plus TTN Support)

Two of the ProACT Plus TTN Support PwMs appreciated having the reminders on the CareApp for the tasks that they had not completed:

> *You get the reminders for what you haven't done which is good, you haven't filled in this and you haven't filled in that you know, which I thought was very good. But I think it's, it is better because they do it by colours and you, you know you haven't answered these questions this week so you've got that. You know just the colour tells you you're, you're behind, you know* (SEP05, M, 73, CHD + HTN + T2D, ProACT Plus TTN Support)

The reminders acted as a way of ensuring that the ProACT Plus TTN Support PwMs took their readings and helped them to become disciplined about looking after their health. SEP20 (M, 72, CHD + T2D, ProACT Plus TTN Support) particularly liked the reminder on the medication management feature as it helped him to remember to take his medication on time, and when taking his medication this in turn reminded him to take his readings. He also felt that the medication management feature would be a useful tool for anybody who did not understand the medication they were taking.

Indeed, because taking their readings became routine for them, two PwMs (one from each trial cohort) stated that they would miss taking them after the trial finished: "*It's part of the day. I'll go and suffer withdrawal symptoms when the day comes to hand it over. I will probably shed a tear, and I'll wonder what am I going to do now*" (SEP43, M, 78, CHD + COPD + HTN, ProACT Plus TTN Support). Other PwMs were determined to keep looking after their health in the future, for example: "*Now, I kind of say to myself 'now SEP48, when this is all finished, you're not to go back to the way you were'*, you know" (SEP48, F, 71, COPD + HTN, ProACT No TTN Support). This was echoed by SEP32 (M, 76, HTN + T2D, ProACT No TTN Support): "*I think it's a good thing and I intend to go on with it right, right throughout the rest of my life*" (SEP32, M, 76, HTN + T2D, ProACT No TTN Support).

7.6.3 Issues with ProACT

The difficulties that arose for the majority of PwMs (ProACT Plus TTN Support=8, ProACT No TTN Support=7) were primarily of a technical nature rather than with the physical use of the iPads or devices. However, two PwMs from ProACT Plus TTN Support spoke about the physical problems they had using the iPad and devices. One PwM had a problem with the volume control buttons on his iPad, while the other PwM spoke about having problems using the blood pressure monitor when he started on the trial – specifically with the placement of the cuff on his arm. However, once the PwMs got used to using the iPad and the blood pressure monitor, both participants were satisfied to continue using them.

The technical issues that PwMs discussed were problems with the iPad such as being locked out of it and needing a password re-set, remembering to keep it charged, manually entering data, and for one PwM, not being able to access her data when visiting her consultant because of not having Internet coverage in the hospital: "*It's no use bringing the iPad in with you because they don't work because there's no Internet*" (SEP47, F, 73, COPD + HTN + Resp., ProACT Plus TTN Support). She was frustrated by this because she wanted to be able to discuss her readings with her HCPs and felt that it was important to be able to show the readings to them.

Other problems with the technology were mentioned and these included issues with the devices not syncing with ProACT: "*The only thing I don't understand about it, is why the hell it [the data] doesn't come in when it should come* in" (SEP14, M, 79, CHD + HTN + T2D, ProACT No TTN Support). Another issue was not being able to enter data into the app at a time after it was supposed to have been done, for example, in the medication management feature if medication details had not been entered on time. One PwM, was also blocked from the app when he was away on holiday. However, this participant acknowledged that the app was simple to use once he was able to access it: “*Oh, when I was able to use ProACT it was just straightforward…once you could log into it, it’s simple to get at, it’s simple to find your way around*” (SEP08, M, 73, CHD + T2D, ProACT No TTN Support).

The majority of difficulties arose with the devices, with 14 PwMs (ProACT Plus TTN Support=7, ProACT No TTN Support=7) reporting having issues with the watch, blood pressure monitor and weighing scales readings. With regard to the watch, 10 PwMs (ProACT Plus TTN Support=3, ProACT No TTN Support=7) spoke of problems with it not recording their steps and sleep, and characterised it as ‘not very effective’ and the readings as ‘pure rubbish’. For example, according to four PwMs (ProACT Plus TTN Support= 1, ProACT No TTN Support=3) the watch at times did not record their steps while doing what SEP05 (M, 73, CHD + HTN + T2D, ProACT Plus TTN Support) characterised as ‘active walking’ i.e., swinging his arms whilst walking. He spoke about pushing a trolley around the supermarket: “*You know, like when you go shopping and you know you put in about 1,000 steps around the store and you come, you come out and you've 10 maybe, you know, like it it's a bit, it's a bit disheartening, really*” (SEP05, M, 73, CHD + HTN + T2D, ProACT Plus TTN Support). For another PwM who played golf, he noted a significant difference in the number of steps stored in the watch compared to a phone app: “*You know you’re getting 15,000 [steps] or whatever it is, whereas the other app, the app on the watch would show maybe 8,000. Probably be nearly 50% difference*” (SEP08, M, 73, CHD+T2D, ProACT No TTN Support).

Regarding the sleep readings, one PwM (SEP02, F, 73, CHD + COPD + HTN, ProACT Plus TTN Support) reported that the watch was not recording her afternoon naps, with the issue for a further five PwMs (ProACT Plus TTN Support=1, ProACT No TTN Support=4) being that it was recording them as being asleep during the night when they knew they were awake. The blood pressure monitor gave SEP10 (M, 68, CHD + HTN + T2D, ProACT Plus TTN Support) readings that were inconsistent, i.e., they were low one day and the next day they were high which he found ‘strange’, and SEP12 (M, 85, CHD + CHF + HTN, ProACT Plus TTN Support) found that his readings were higher than those taken by his GP. Finally, two PwMs (both from ProACT Plus TTN Support) discussed how the readings on the weighing scales either would not sync to the ProACT CareApp or it would not take a reading. The findings now continue with those from theme two – engagement with the ProACT CareApp and devices.

7.7 Theme two – engagement with the ProACT CareApp and devices

Theme two reports the findings from questions related to the PwMs’ engagement with the ProACT CareApp and devices. Two sub-themes were identified: (i) using ProACT; (ii) motivation to use ProACT and engage in self-management behaviours.

7.7.1 Using ProACT

In this sub-theme, the PwMs discussed their engagement with ProACT in terms of how often they took their symptom readings and how often they reviewed them in the CareApp. Their usage of the additional CareApp features – the self-report feature, the exercise goal setting feature, the medication management feature and the education content – was also reported on. Finally, their perception of whether their engagement had changed or not since the start of the trial was discussed, including why and how this occurred.

7.7.1.1 Taking and looking at the readings

Of the 24 PwMs, 22 (11 from each cohort) reported that they were taking their readings once daily, with another ProACT No TTN Support PwM stating that he took his blood pressure twice daily if he was feeling unwell. Further, one PwM in ProACT Plus TTN Support reported that he had stopped taking his readings a month previously due to starting cancer treatment, but was intending to restart it once his condition stabilised. When asked about how often they looked at their readings, 10 (ProACT Plus TTN Support=5, ProACT No TTN Support=5) PwMs stated that they looked at them either daily or frequently (i.e., several times a week), nine (ProACT Plus TTN Support=3, ProACT No TTN Support=6) looked at them sometimes and five (ProACT Plus TTN Support=4, ProACT No TTN Support=1) never looked at them. The reasons given for looking at the readings were 'out of curiosity', 'to keep an eye on things' or because of concern over fluctuations in readings, particularly when one was high. Of the five PwMs who never looked at their readings, SEP15 (M, 73, CHD + COPD + T2D, ProACT Plus TTN Support) for example, did not feel the need to because of being monitored by the TTNs who he knew would contact him if there was a problem. SEP23 (M, 70, HTN + T2D, ProACT No TTN Support), although taking his readings daily, did not use the iPad to look at those readings in the CareApp or engage with any other features within the app because he was afraid of damaging it, and the remaining PwMs (all from ProACT Plus TTN Support) were not interested in looking back at the trends in their readings because they felt that their symptoms were stable.

7.7.1.2 Using the CareApp features

Regarding the self-report feature which concerned questions about symptoms, anxiety, mood and fatigue, 13 PwMs (ProACT Plus TTN Support=6, ProACT No TTN Support=7) stated that they used it, with five PwMs using it frequently (ProACT Plus TTN Support=2, ProACT No TTN Support=3) and eight using it sometimes (ProACT Plus TTN Support=4, ProACT No TTN Support=4). For the 11 PwMs who did not use it, the reason given by four PwMs (ProACT Plus TTN Support=1, ProACT No TTN Support=3), was that they were unaware of the feature. Five were uninterested in using it (ProACT Plus TTN Support=1, ProACT No TTN Support=4), while one ProACT Plus TTN Support PwM did not use the feature because he had not been told to, and finally, another ProACT Plus TTN Support participant felt it was irrelevant for him.

Seven PwMs (ProACT Plus TTN Support=4, ProACT No TTN Support=3) used the exercise goal setting feature. One ProACT Plus TTN Support PwM reported that his number of steps per day had decreased due to injury while two PwMs (one from each cohort) stated that they had increased their goals over the course of their participation, for example: "*Now I have one there for three, three, I think I had 2,000 [steps] initially. And I was well exceeding that and then I put her up to 3,000, but now it's gone up to four or five. I did 7,000 and I got the best congratulations*" (SEP02, F, 73, CHD + COPD + HTN, ProACT Plus TTN Support). The remaining four PwMs all from ProACT No TTN Support reported no change in the goals that they had set at the outset of the trial. This was because they were happy with the level of exercise that they were getting and did not see the need to either increase or decrease it. Of the 17 PwMs (ProACT Plus TTN Support=8, ProACT No TTN Support=9) not using this feature, reasons given by ten PwMs ProACT No TTN Support=6) were an inability to exercise due to their conditions, and seven PwMs (ProACT Plus TTN Support=4, ProACT No TTN Support=3) who did not see the need to set exercise targets as they perceived that they took enough exercise.

Seven PwMs (ProACT Plus TTN Support=4, ProACT No TTN Support=3) also reported that they used the medication management feature for recording their medication intake. SEP05 (M, 73, CHD + HTN + T2D, ProACT Plus TTN Support) had thought that he would not find this feature useful as he was using a daily pill box. However, he found it to be 'a great reminder', especially for taking his evening tablets which he was prone to forget. Six PwMs (three from each cohort) felt that they did not need to use the feature because they were happy with the blister pack or pill box systems they were already using. Finally, while eight PwMs (ProACT Plus TTN Support=3, ProACT No TTN Support=5) were aware of the medication management feature but chose not to use it, three PwMs (ProACT Plus TTN Support=2, ProACT No TTN Support=1) were unaware of it.

The educational content which consisted of videos relating to the PwMs' management of their conditions, and information about how to use the devices and app was accessed by 10 PwMs (ProACT Plus TTN Support=6, ProACT No TTN Support=4). The 14 PwMs (ProACT Plus TTN Support=7, ProACT No TTN Support=7) who had not accessed the videos were either unaware of them, or felt that they knew enough about their conditions because they had been living with them for a long time, for example: "*I think I have been living with this for over 20 years and I'm kind of, I could be making videos myself*" (SEP11, M, 73, COPD + T2D, ProACT No TTN Support).

7.7.1.3 Perceived changes in engagement levels

The majority (19) of the PwMs (ProACT Plus TTN Support=9, ProACT No TTN Support=10) reported no change in their level of engagement with the CareApp and devices since the start of the trial. This was due to reasons such as not seeing the need to change the frequency as they had established routines for using them and were happy to stick to those routines, or because of symptom stabilisation. However, five PwMs (ProACT Plus TTN Support=3, ProACT No TTN Support=2) reported that their usage of ProACT had changed, with three PwMs (ProACT Plus TTN Support=1, ProACT No TTN Support=2) using it more frequently, and two PwMs both from ProACT Plus TTN Support using it less frequently. For example, SEP01 (M, 71, CHD + HTN + T2D, ProACT No TTN Support) reported that he was using the technology more because he had explored the CareApp and found new features to engage with, while conversely, SEP65 (M, 71, CHD + Resp., ProACT Plus TTN Support) stated that he was using the technology less: "*I'm not using it as often as I was. There's no particular reason why I do, it's just however I feel on the day*" (SEP65, M, 71, CHD + Resp., ProACT Plus TTN Support).

7.7.2 Motivation to use ProACT and engage in self-management behaviours

In this sub-theme, the participants answered questions in relation to their motivation to use ProACT. The TTNs support (this will be discussed in theme three), contributing to research for different reasons and the perceived benefits from engaging with ProACT were identified as motivators and will now be discussed in the following sections.

For eleven PwMs (ProACT Plus TTN Support=6, ProACT No TTN Support=5) contributing to research for various reasons was a motivator to use ProACT. The knowledge that she was contributing to research was enough motivation for SEP26 (F, 69, CHD + COPD + T2D, ProACT No TTN Support) to use the technology every day, while SEP12 (M, 85, CHD + CHF + HTN., ProACT Plus TTN Support) spoke about being motivated because he was taking part in a Europe-wide research programme: "*It wasn't motivated by concern about my health or monitoring my health. It was more an interest in a Europe-wide technology experiment that's what excited me*" (SEP12, M, 85, CHD + CHF + HTN, ProACT Plus TTN Support). One PwM felt it was important to contribute to knowledge in order to advance science:

> *I'm a firm believer in anything that will advance science… I'm of the opinion that the more people get involved in these things, the better for humanity, the better for health-wise, for everything, because we stay in the dark ages if we don't have these projects* (SEP43, M, 78, CHD + COPD + HTN, ProACT Plus TTN Support)

On the other hand, SEP48 (F, 71, COPD + HTN, ProACT No TTN Support) spoke about wanting to contribute because she hoped that a cure for her COPD would be found through research, and for SEP05 (M, 73, CHD + HTN + T2D, ProACT Plus TTN Support) using ProACT to provide feedback to the research team on his experiences with it was important to him. Three PwMs (ProACT Plus TTN Support=1, ProACT No TTN Support=2) did not feel that they were personally benefitting from using the technology but were motivated to do so because they had given a commitment to participate in the trial. For example: "*I don't know what it's doing for me on a personal basis other than it's telling me that I'm still alive…But other than that I'll carry on doing it because I committed to doing it*" (SEP14, M, 79, CHD + HTN + T2D, ProACT No TTN Support). Wanting to help other people was mentioned by some PwMs. For example, SEP07 (M, 89, CHD + HTN + T2D, ProACT Plus TTN Support) wanted to be able to 'give something back', while SEP13 (F, 68, CHD + T2D, ProACT No TTN Support), SEP42 (M, 71, Resp. + T2D, ProACT No TTN Support) and SEP48 (71, COPD + HTN, ProACT No TTN Support) spoke about helping the research team to help others, for instance: "*Well yeah, if it helps you to help somebody else. Now I don't know if my situation can…but if it does help then it's brilliant*" (SEP13, F, 68, CHD + T2D, ProACT No TTN Support). SEP02 (F, 73, CHD + COPD + HTN, ProACT Plus TTN Support) spoke about a growing awareness of what she needed to do to self-manage her conditions, how the monitoring had become part of her day and that she felt good about participating in the trial, so consequently she wanted to be able to help others: "*Yeah, so you know, I feel quite good about doing this and hopefully helping others and helping myself at the same time*" (SEP02, F, 73, CHD + COPD + HTN, ProACT Plus TTN Support).

Across both trial cohorts the 24 PwMs discussed the benefits that they felt they had gained from using ProACT which motivated them to continue using it. SEP11 (M, 73, COPD + T2D, ProACT No TTN Support) stated: *It's a driving force more than anything else. What I'm* *doing is very effective, it kind of gives you motivation if I can put it that way*" (SEP11, M, 73, COPD + T2D, ProACT No TTN Support). Factors such as gaining health knowledge, having readings readily available, improved health behaviours and improvements in health were identified. Firstly, learning about their conditions was spoken about by the PwMs (ProACT Plus TTN Support=9, ProACT No TTN Support=8) who recounted how they had learned what their heart rate, blood pressure and blood sugar readings should be from having access to the graphs on the CareApp, by using the educational videos and by using the medication management feature. For example, the readings meant that six of the PwMs (ProACT Plus TTN Support=3, ProACT No TTN Support=3) knew when they had a spike in their conditions, were able to pinpoint when it occurred and what had caused it. They knew whether action needed to be taken about those spikes, such as contacting their GP, taking the readings again if they felt they were wrong, drinking water, taking exercise or washing their hands after fruit preparation, for instance:

> *Like the blood pressure. If you're getting high readings, you might let it, you might set a time limit. Sorry, I'll set a time limit of when I'm going to do something about it…if I get a few high readings in, in a row I'd be scattering and visit the GP to discuss it, you know* (SEP05, M, 73, CHD + HTN + T2D ProACT Plus TTN Support)

> *And then the blood pressure is not, it's high now, but was it yesterday or two days ago, it was very high. It was 160 something and I went "oh God". But then when I did it myself in the evening then it was grand it had gone down you know. But it's brilliant, it's very handy for that now to be honest with you*
> (SEP26, F, 69, CHD + COPD + T2D, ProACT No TTN Support)

SEP01 (M, 71, CHD + HTN + T2D, ProACT No TTN Support) spoke about being 'up-to-date' in his knowledge of his conditions and also felt better able to communicate with his HCPs as a result of having access to his readings: "*Oh well, what it does is it enhances your ability to talk to the medical consultants…I'd be very brief because I know exactly what I want to ask and I* *know exactly what they're saying to me*" (SEP01, M, 71, CHD + HTN + T2D, ProACT No TTN Support).

Secondly, having their readings easily available was important for all of the PwMs, for example, SEP07 (M, 89, CHD + HTN + T2D, ProACT Plus TTN Support) who was concerned about his heart rate and blood pressure explained that being able to see that those readings were within range was 'colossal' for him hence, he kept using ProACT. SEP42 (M, 71, Resp. + T2D, ProACT No TTN Support) appreciated that he could check out his readings whenever he needed to and felt that being able to do so took 'a lot of guess work' out of managing his health. SEP19 (M, 87, CHD + T2D, ProACT No TTN Support) felt that the medication management feature helped him to see the effects of his medication and when looking back at his reading trends, he was able to see what changes he needed to make: "*If I'm feeling a bit off, is it reflected in the figures? It's easy enough for me to look at a trend and say 'oh you know that's something that I need to change*"' (SEP19, M, 87, CHD + T2D, ProACT No TTN Support). Finally, because his diabetes was a long-term health issue for him, SEP08 (M, 73, CHD + T2D, ProACT No TTN Support) felt that if he did not monitor his symptoms he was 'going to store up trouble' for himself in the future, which motivated him to use ProACT.

Thirdly, improvements in health behaviours such as becoming more proactive in seeking help from their HCPs, getting more exercise, improvements in conditions and weight loss were identified by some PwMs (ProACT Plus TTN Support=5, ProACT No TTN Support=3) as motivating them to engage with the technology. For instance, SEP05 (M, 73, CHD + HTN + T2D, ProACT Plus TTN Support) saw his GP about his HTN symptoms and SEP23 (M, 70, HTN + T2D, ProACT No TTN Support) made an appointment with his GP and Practice Nurse to get blood tests done because he wanted 'to keep on the right track'. Getting more exercise such as walking and cycling also proved to be motivating for participants because they could see their progress in their readings:

> *It keeps you I would say the steps one keeps you wanting to do the exercises every day rather than, you know, doing them once a week or once every two weeks. I think it's good that way because kind of you say you want to keep a graph because the only way you're going to get a weekly graph is if you do it every day. So, it does encourage you it does* (SEP20, M, 72, CHD + T2D, ProACT Plus TTN Support)

SEP65 (M, 71, CHD + Resp., ProACT Plus TTN Support) spoke about pushing himself to walk daily as he felt that his health had improved, which was echoed by SEP43 (M, 78, CHD + COPD + HTN, ProACT Plus TTN Support) who cycled five miles every day and who also felt that his health had improved since the start of the trial. Three PwMs (ProACT Plus TTN Support=1, ProACT No TTN Support=2) had lost weight and for them this was a motivating factor. Further, SEP13 (F, 68, CHD + T2D, ProACT No TTN Support) spoke about being overweight but had never thought about losing some until she started weighing herself regularly, which changed her attitude and made her want to lose it: "*I knew I was overweight, but now seeing it every day it's a different, I have a different outlook on it, you know what I mean. But now…I want to lose weight*" (SEP13, F, 68, CHD + T2D, ProACT No TTN Support).

7.8 Theme three– the role of the TTNs in supporting engagement with ProACT

This theme concerned the supports given to the ProACT Plus TTN Support PwMs to self-manage their health conditions by the TTNs, the relationship between them and the impact of the TTNs on the participants. There were four sub-themes identified in the data: (i) the TTNs' support; (ii) the nature of the PwMs' relationship with the TTNs; (iii) the TTNs' influence on engagement levels with the TTNs; and (iv) self-management without the TTNs.

7.8.1 The TTNs' support

In the first sub-theme, being monitored was an important support for the PwMs who felt reassured by knowing that the TTNs were checking on them and were "*there at the end of the phone*" (SEP09, M, 82, CHD + COPD + HTN + T2D, ProACT Plus TTN Support) and also "*were keeping an eye on things*" (SEP15, M, 73, CHD + COPD + T2D, ProACT Plus TTN Support). For SEP20 (M, 72, CHD + T2D, ProACT Plus TTN Support), he liked the fact that he knew he was going to get a phone call from the TTNs on a certain date, and he could use that phone call to ask the TTNs' opinion on something that was 'bothering him' rather than contact his GP about it. In addition, the reassurance of being monitored was mentioned by nine of the PwMs as being important to them, for instance: "*And that they monitor the readings. That's reassuring, yes*" (SEP12, M, 85, CHD + CHF + HTN., ProACT Plus TTN Support). Reliability was mentioned by seven PwMs in reference to the fact they knew that the TTNs would contact them in the case of high readings, and also the quickness with which they responded to alerts, for example:

> *Because if the blood pressure goes up, occasionally it does, and then they will ring me and ask all the questions in relation to that, you know straight away. But you know it is, it would be wonderful if somebody was spiking like that all the time. It would be wonderful, the girls' ringing and going through it with you, you know?*
> (SEP09, M, 82, CHD + COPD + HTN + T2D, ProACT Plus TTN Support)

PwMs expected that they would get a call if a reading was too high: "*Like if my heart rate went too high, I would expect somebody to phone me because I'm worried about my heart…and they do respond very quickly*" (SEP02, F, 73, CHD + COPD + HTN, ProACT Plus TTN Support). This reliability instilled a sense of confidence that the TTNs would immediately contact them if a reading was outside a person's normal range: "*There's an awareness that they are there if any problems show up, I have the confidence that they are there and that they will respond promptly*" (SEP12, M, 85, CHD + CHF + HTN, ProACT Plus TTN Support).

In terms of the advice given to them about their health conditions such as their blood pressure, blood sugar levels and heart rate for example, nine of the PwMs spoke about following it because the advice was ‘practical’, ‘good’, the TTNs were ‘qualified nurses’, they felt that the TTNs were ‘professional’ and also because it was: “*The sensible thing to do*” (SEP12, M, 85, CHD + CHF + HTN, ProACT Plus TTN Support). For one PwM whose mother had experienced strokes, he was keen to avoid the same experience: “*Will I take advice, I will, I certainly will take advice, and will I heed the advice? I certainly will*” (SEP43, M, 78, CHD + COPD + HTN, ProACT Plus TTN Support). Of the other three PwMs, one PwM (SEP47, F, 73, COPD + HTN + Resp., ProACT Plus TTN Support) stated that she did not always take the TTNs’ advice because although her blood pressure was high, she knew her own body well enough to know that she was alright, and the other two PwMs stated that they had not received any advice from the TTNs. The TTNs’ persistence with giving advice was referred to by SEP43 (M, 78, CHD + COPD + HTN, ProACT Plus TTN Support) who appeared to appreciate it: “*They kept after me until I went over and got a what you call it, got a monitor, a 24-hour monitor and they’re putting pressure on me now. Now, I don’t mean pressure in a bad way, I mean pressure in a good way to do something about it*” (SEP43, M, 78, CHD + COPD + HTN, ProACT Plus TTN Support).

Confidence was mentioned by three PwMs in relation to the advice, both in terms of the advice giving them the confidence to carry on with their self-management, and also in terms of having confidence in the TTNs. For SEP43, (M, 78, CHD + COPD + HTN, ProACT Plus TTN Support) the confidence he had in their advice meant that he would consider contacting the TTNs first if he did not want to go to his GP practice: “*Now this is the point, I could make a first port of call if I didn’t want to go over to the doctor or go over to the Practice Nurse either*” (SEP43, M, 78, CHD + COPD + HTN, ProACT Plus TTN Support). In addition, his confidence in them meant that he was willing to go to his GP if they told him that he needed to, even if he did not see the need himself.

Another question enquired about the importance to the PwMs of having their health-related questions answered by the TTNs. This was not important to four PwMs, who felt well able to self-manage their conditions: “*It’s not. I’m managing myself so I don’t know. I’ve just read those information things within the app in the iPad*” (SEP02, F, 73, CHD + COPD + HTN, ProACT Plus TTN Support). For others such as SEP10 (M, 68, CHD + HTN + T2D, ProACT Plus TTN Support) and SEP47 (F, 73, COPD + HTN + Resp., ProACT Plus TTN Support), they felt happier to speak to their HCPs about their health concerns. However, for the six other PwMs, they felt it was important to have their queries answered because it would alleviate anxiety and would also save them from having to visit the GP.

Impacts on well-being were noted as the PwMs spoke in terms of the sense of security and reassurance they felt in knowing they were being monitored. One PwM found it was a ‘*big comfort*’ and: “*Lovely having them checking to make sure that everything was OK, you know*” (SEP10, M, 68, CHD + HTN + T2D, ProACT Plus TTN Support). SEP55 (F, 67, CHF + HTN + Resp., ProACT Plus TTN Support) felt that it was good knowing that the TTNs were there for her and that it ‘felt nice’ when they rang to enquire how she was doing. She noted that the triage service would be important to older adults living alone:

> *I feel sorry for any old person who lives on their own who has medical problems. I think it would just be a nightmare and if you don't have anybody you know to speak up for you it, it has to be very, very hard. Because GPs are just so, so busy they don’t have the time* (SEP55, 67, CHF + HTN + Resp., ProACT Plus TTN Support)

Being monitored by the TTNs incentivised five PwMs to take their readings. For SEP20 (M, 72, CHD + T2D, ProACT Plus TTN Support), he felt that knowing his readings were being looked at and that he would get a call from the nurses meant he was going to take them: “*You’d say well, it’s the fact that they’re monitoring you and calling you is a big incentive to* *do it. Now you know it's like somebody adding on another medical person watching you*" (SEP20, M, 72, CHD + T2D, ProACT Plus TTN Support). Further, SEP65 (M, 71, CHD + Resp., ProACT Plus TTN Support) reported that he was taking his readings more often as he had received a phone call from the TTNs when he had missed taking them for a few days, and felt that the encouragement he got from the TTNs helped him to '*keep going*'.

7.8.2 The nature of the PwMs' relationship with the TTNs

In this sub-theme the 12 PwMs were asked questions about the nature of their relationship with the TTNs. When asked if they had experienced any challenges in dealing with them, all twelve responded that their experiences when dealing with the TTNs were positive, with several using the word 'good' and 'friendly' to describe their relationship. For example, one participant spoke about the TTNs being: "*Very friendly, very easy to speak to*" (SEP02, F, 73, CHD + COPD + HTN, ProACT Plus TTN Support). She also noted that "*we usually just have a bit of a laugh*". However, three PwMs stated that they did not feel that they had established a relationship with the TTNs at the time of the interviews (three months into the trial), they had only had a small number of phone calls with them. Nevertheless, they found the TTNs to be helpful and knowledgeable and hence, were willing to take their phone calls: "*I've only had like three, three or four phone calls from them. So really, I haven't built up a relationship as such I would say. They've all been very good, been very knowledgeable when they rang, and very helpful. I wouldn't hesitate in taking the call from them*" (SEP20, M, 72, CHD + T2D, ProACT Plus TTN Support).

Personal characteristics of the TTNs that PwMs mentioned were 'caring', 'empathic', 'understanding', 'pleasant', 'lovely' and 'nice'. For example, SEP05 (M, 73, CHD + HTN + T2D, ProACT Plus TTN Support) felt that the TTNs were caring and interested in him personally:

> *They're very interested in your feelings rather than just the bare figures you know, like you have high blood pressure to be asked 'how do you feel?' You know, 'are you tired? Dizzy?' Right like that, you'd say yes or no. But it was in a good, caring manner I thought* (SEP05, M, 73, CHD + HTN + T2D, ProACT Plus TTN Support)

SEP55 (F, 67, CHF + HTN + Resp., ProACT Plus TTN Support) also felt that they were interested in her and it was not 'just about the readings' because they asked questions such as if she had any worries or anything that she needed to ask them. Further, she spoke about the fact that they took time to talk about her concerns and did not rush the conversation with her to talk to somebody else. This was in comparison to her experience with her GP:

> *Oh yeah, they're really, really nice. You know sometimes now, if you were on the phone to the doctor or you go into the doctor, I mean it's in, out you know, €55.00. It's you know it's not, you just go in with whatever you have and you know, if you have anything else well, shut up about it because you haven't time to talk about it or they haven't time to talk about it. So, you never feel when you're on the phone to them [the TTNs] that you have to be quick or that they're waiting to ring somebody else when you're finished* (SEP55, F, 67, CHF + HTN + Resp., ProACT Plus TTN Support)

This was echoed by another PwM who felt that the phone calls were important to the TTNs: "*You didn't get the feeling that it's just a tick box exercise, you know what I mean. They were actually calling to see genuinely how you were*" (SEP20, M, 72, CHD + T2D, ProACT Plus TTN Support). SEP55 (F, 67, CHF + HTN + Resp., ProACT Plus TTN Support) felt that she could say what she wanted to say to the TTNs, which built up her trust in them, as she felt that "they were on your side" (SEP55, F, 67, CHF + HTN + Resp., ProACT Plus TTN Support).

7.8.3 The TTNs' influence on engagement levels with ProACT

The ProACT Plus TTN Support PwMs were firstly asked whether the TTNs made a difference to how often they used ProACT. For one PwM (SEP55, F, 67, CHF + HTN + Resp., ProACT Plus TTN Support), she reported that if she did not have the TTNs' support she would use the CareApp and devices more frequently as she would not have the 'reassurance' of having them monitoring her. Five PwMs stated that they felt that they would use the technology less often, because they would not be monitored by the nurses which was what incentivised them to take their readings. For example: "*Sometimes I might say God, I didn't do that today. I better do it, you know, because they'll be watching it. And if I didn't think they were watching it, I'd say sure we'll do it tomorrow*" (SEP09, M, 82, CHD + COPD + HTN + T2D, ProACT Plus TTN Support). Of the six PwMs who stated that the TTNs did not make a difference to their engagement with the technology, one of the PwMs (SEP12, M, 85, CHD + CHF + HTN, ProACT Plus TTN Support) spoke about not feeling it necessary to use the technology more or less frequently than he was doing, while others had given a commitment to the trial and were determined to use ProACT regardless: "*I was going to use it anyway, you know? I was determined to use it anyway. The Caredoc nurses can only encourage you to use it, but that's all*" (SEP10, M, 68, CHD + HTN + T2D, ProACT Plus TTN Support).

Secondly, the PwMs were asked how the TTNs motivated them to use the technology in terms of their engagement levels with it. The four PwMs who stated that they would use the technology less frequently without the TTNs also felt that they motivated them to use it. For instance, SEP20 (M, 72, CHD + T2D, ProACT Plus TTN Support) felt that there would be 'no point' in taking his readings without the 'personal touch' of the TTNs monitoring them, and SEP43 (M, 78, CHD + COPD + HTN, ProACT Plus TTN Support) felt: "*The technology is no good to me unless I had the Caredoc, unless there was a Caredoc nurse at the end of it*" (SEP43, M, 78, CHD + COPD + HTN, ProACT Plus TTN Support). Conversely, SEP55 (F, 67, CHF + HTN + Resp., ProACT Plus TTN Support) stated that she did not feel motivated by the nurses to use it, because she 'would use it anyway', which was echoed by two other participants. Finally, because SEP05 (M, 73, CHD + HTN + T2D, ProACT Plus TTN Support) and SEP15 (M, 73, CHD + COPD + T2D, ProACT Plus TTN Support) were in 'the habit' of using ProACT they felt that they did not need any motivation to engage with it: "*It's just something that I do each morning as a matter of course*" (SEP15, M, 73, CHD + COPD + T2D, ProACT Plus TTN Support).

7.8.4 Self-management without the TTNs

One question enquired how the participants thought they would self-manage without the TTNs' support. For one PwM it made no difference as she felt that she did not need the support: "*Because as I say I don't pass much heed of what they say anyway*" (SEP47, F, 73, COPD + HTN + Resp., ProACT Plus TTN Support). For the remaining 11 PwMs, they said that they would manage as they had been doing previously, such as by contacting their GP if they felt unwell. This was because they had been self-managing well before the SEURO project. Nevertheless, SEP65 (M, 71, CHD + Resp., ProACT Plus TTN Support) felt that having the support was necessary as: "*Sometimes I mightn't know…if I'm getting worse…I feel like they're necessary in that they know what exactly is happening much quicker than I would know*" (SEP65, M, 71, CHD + Resp., ProACT Plus TTN Support). This was echoed by SEP05 (M, 73, CHD + HTN + T2D, ProACT Plus TTN Support) who reported that prior to SEURO he had taken the wrong type of insulin and that it would have been 'great' to have had advice from the TTNs available to him at that time. Further, three PwMs said that they would like to be able to ring the TTNs for advice about whether they needed to visit their GP or not if their readings were high. SEP20 (M, 72, CHD + T2D, ProACT Plus TTN Support) felt that if he could do so, it would mean that his GP visits were purposeful: "*Then you're not, you're not tormenting your GP. You're going to your GP for a reason*" (SEP20, M, 72, CHD + T2D, ProACT Plus TTN Support).

Three of these PwMs responded that they would have been slower to contact their HCPs without the TTNs to prompt them to do so. One participant (SEP05, M, 73, CHD + HTN + T2D, ProACT Plus TTN Support) spoke about being slower to respond to a high reading without the TTNs, while another PwM (SEP43, M, 78, CHD + COPD + HTN, ProACT Plus TTN Support) believed he would be: "*Putting things on the long finger*" and felt that by having the TTNs' support he was more likely to pre-empt getting ill: "*If I didn't have the Caredoc nurse to ring me about say, what yon, about my blood pressure and the what yon, I would probably maybe let it drag along until I get ill*" (SEP43, M, 78, CHD + COPD + HTN, ProACT Plus TTN Support). Further, SEP20 (M, 72, CHD + T2D, ProACT Plus TTN Support) reported that: "*I think if you didn't have the support, you'd go back to relying on what you were [doing] before*" (SEP20, M, 72, CHD + T2D, ProACT Plus TTN Support), and for him, this was not taking his readings because "*nobody's looking*".

7.9 Chapter 7 summary of findings

This chapter presented the quantitative and qualitative findings from Part 2 of Study 2 that was conducted with a sub-set (n=24) of the 64 PwMs participating in the SEURO project and whose data were included in Chapter 6. 12 of the PwMs had support from the same TTNs as those in Study 1 to self-manage their conditions and 12 self-managed without that support. The first set of findings summarised below is from the objective engagement data that were collected in Netwell Admin.

ProACT platform engagement:

1. **Overall usage:** Engagement was higher in ProACT Plus TTN Support (with TTN support) than ProACT No TTN Support (without support) – 83.92% vs 78.67% of days; and,
2. **Age differences:** The 85+ years age group showed the most variability in engagement – highest engagement in ProACT Plus TTN Support (94%) and lowest in ProACT No TTN Support (54%). ProACT No TTN Support engaged slightly more than ProACT Plus TTN

Support in the other age categories (78.13% vs 75.80% days engaged, 65-74 years and 88.33% vs 88% days engaged, 75-85 years age groups).

Key insight: TTN support led to higher overall engagement with ProACT, particularly in the oldest age group.

Device usage:

1. **Overall vitals monitoring:** ProACT Plus TTN Support recorded more vitals measures than ProACT No TTN Support (3,328 vs 2,715), averaging 128 vs 104.42 measures per week; and,
2. **Age differences:** ProACT No TTN Support's 65-74 years age group recorded the most vitals measures (1,711), while ProACT No TTN Support's 85+ group recorded the least (134).

Key insight: TTN support ensured that ProACT Plus TTN Support PwMs engaged more with the devices, while the oldest age group without TTN support engaged the least.

Engagement with the CareApp and its features:

1. **Overall usage of the CareApp and the vitals devices:** Engagement with the CareApp was slightly higher in ProACT Plus TTN Support than ProACT No TTN Support (61.67% vs 57.08% days engaged), and also with the vitals devices (57.75% vs 54.67% days engaged);
2. **Age differences:** ProACT No TTN Support's 85+ years age group was the only ProACT No TTN Support age group that engaged more with the CareApp than ProACT Plus TTN Support (34% vs 16.50% days engaged). ProACT Plus TTN Support's 75-84 years age

group had the highest number of days engagement (83.80%) with the devices, while the lowest (16.50%) was in ProACT Plus TTN Support’s 85+ years age group;

3. **Overall features section usage:**
    - ProACT Plus TTN Support interacted more with the self-report and education features than ProACT No TTN Support (20.50% and 4.50% vs 11.75% and 2.42% days engaged), whereas the medication feature was engaged with more by ProACT No TTN Support (26.42% vs 24.17% days engaged);
    - ProACT Plus TTN Support on average completed significantly more surveys than ProACT No TTN Support (112.75 vs 71.83); and,
    - ProACT Plus TTN Support set activity goals on a higher average number of weeks than ProACT No TTN Support (23 vs 21), conversely, ProACT No TTN Support met activity goals on a higher average number of weeks than ProACT Plus TTN Support (11.50 vs 9.20).
4. **Age differences:**
    - ProACT No TTN Support’s 75-84 years age group engaged most with the medication feature (52.33% days engaged), and the 65-74 years age group in both cohorts interacted with it the most (ProACT Plus TTN Support=25%, ProACT No TTN Support=19.25% days engaged);
    - The education feature had the lowest engagement in the 65-74 years group (ProACT Plus TTN Support=3.60%, ProACT No TTN Support=1.13% days engaged);
    - The highest average number of surveys completed was by ProACT Plus TTN Support’s 65-74 years age group (171.40), and the lowest by ProACT Plus TTN Support’s 85+ years age group (0.50); and,

    - The highest average number of weeks a goal was met was 20 weeks (ProACT Plus TTN Support's 75-84 years age group), while the lowest was 2.67 weeks (ProACT No TTN Support's 65-74 years age group).

Key insight: Support from the TTNs ensured that ProACT Plus TTN Support engaged more than ProACT No TTN Support with the CareApp, its features and the vitals devices. Their support also fostered engagement with the majority of the features across the different age groups. However, despite setting fewer activity goals, ProACT No TTN Support met them more consistently.

TTN supports to ProACT Plus TTN Support PwMs:

1. **Overall supports:**
    - the TTNs made a total of 147 phone calls to the 12 PwMs. Of these, 72 were scheduled and 75 were unscheduled;
    - Arising from these calls 18 referrals for seven participants were made to other HCPs. 17 of these were for the GP and one was unspecified. One participant received eight GP referrals as well as the unspecified referral; and,
    - The TTNs dealt with 563 device alerts, the majority of which (473) were dismissed and 90 were addressed. The blood pressure monitor caused the most alerts (428), while the pulse oximeter caused the fewest (27).
2. **Supports by age group:**
    - The largest number of the 147 phone calls made by the TTNs was to the 65-74 years age group (83);

  - Of the 18 referrals made by the TTNs to other HCPs, the 75-85 years age group received the largest number (11 for the GP and one referral which was unspecified); and,
  - The blood pressure monitor in the 75-84 years age group caused the highest number of alerts (196), while the lowest number was three for the blood glucose monitor in the 65-74 years age group.

Key insight: The TTNs provided a high level of practical support to the ProACT Plus TTN Support PwMs through their phone calls, making referrals and dealing with the device alerts. The 75-84 years age group needed the most support as they generated the highest number of alerts and referrals.

This chapter now continues with presenting a summary of the key qualitative findings from the 24 semi-structured interviews.

Theme one – experiences with using DHT:

1. Most PwMs (ProACT Plus TTN Support=7, ProACT No TTN Support=8) had prior experience using DHT, especially blood glucose monitors, blood pressure monitors, and pulse oximeters, although some participants had not been taking readings regularly before SEURO began (ProACT Plus TTN Support=5, ProACT No TTN Support=4);
2. 11 PwMs in each trial cohort found the ProACT platform easy to use;
3. However, eight participants (ProACT Plus TTN Support=5, ProACT No TTN Support=3) had negative perceptions, describing using the platform as ‘a chore’ and the trial as ‘repetitive’ and ‘tedious’; and,

4. Technical issues with the iPad were reported and the watch caused the most problems for participants who reported inaccurate step and sleep tracking.

Key insight: The majority of the participants were familiar with DHT prior to SEURO and found the ProACT platform easy to use. Nevertheless, there were technical issues and some negative perceptions of the trial reported, which highlights that user satisfaction is not always guaranteed.

Theme two – engagement with the DHT:

1. Most PwMs took daily readings (ProACT Plus TTN Support=11, ProACT No TTN Support=12);
2. 10 checked readings daily (five from each cohort) while five never checked them (ProACT Plus TTN Support=4, ProACT No TTN Support=1);
3. Reasons for not checking the readings included TTN support, symptom stabilisation or fear of damaging the iPad;
4. The majority of PwMs took the readings regularly to monitor their health and manage conditions independently of their GPs;
5. Use of the CareApp features:
    - 12 PwMs used the self-report feature (ProACT Plus TTN Support=6, ProACT No TTN Support=7);
    - Seven PwMs used the exercise goal setting feature (ProACT Plus TTN Support=4, ProACT No TTN Support=3);
    - Seven PwMs used the medication feature (ProACT Plus TTN Support=4, ProACT No TTN Support=3);

    - 10 PwMs used the educational content (ProACT Plus TTN Support=6, ProACT No TTN Support=4); and,
    - Some PwMs didn't use the features due to a lack of awareness.
6. 19 participants reported that their engagement with ProACT had not changed, one PwM in ProACT Plus TTN Support used it more frequently and two in ProACT No TTN Support used it less frequently; and,
7. Motivators to use ProACT were contributing to research, gaining health knowledge and improving health behaviours. Others stayed committed to the trial despite perceiving limited benefits for themselves in doing so.

Key insight: The majority of the PwMs were consistent in taking their readings to self-manage their health.

Theme three – the role of the TTNs in supporting DHT engagement:

1. Seven ProACT Plus TTN Support PwMs felt reassured by the TTN monitoring and trusted that they would be contacted if their readings were high;
2. Nine participants followed the TTNs' advice seeing it as practical;
3. Four PwMs did not feel it important to have their health-related questions answered as they felt capable of managing their conditions themselves;
4. Six PwMs found that the TTN support helped to alleviate their anxiety or prevented a GP visit;
5. Five participants stated they would use the technology less without the TTN monitoring, while one indicated she would use it more frequently and six reported that the TTNs made no difference in their usage of ProACT;

6. Relationships with the TTNs were described as ‘good’ and ‘friendly’, with the TTNs being characterised as ‘caring’, ‘empathic’ and ‘understanding’; and,
7. One PwM felt no need for the TTN support, 11 felt they would manage their health as previously but five valued the TTNs for spotting exacerbations, their advice and prompting action.

Key insight: The TTNs’ support provided the PwMs with a strong sense of security, with their monitoring and advice being highly valued as they helped to alleviate anxiety and prevent visits to the GP. The personal connection and trust in the TTNs played a key motivational role in the PwMs’ engagement with ProACT.

Chapter 8 follows with a discussion of the findings from the two studies that have been presented in the present chapter and previously in Chapters 5 and 6.

Chapter 8: Discussion

8.0 Introduction

This chapter discusses the research findings from the two studies that were conducted in order to answer the research question posed by this PhD project: '*would older PwMs engage in regular and sustained digital self-management of their health without the support of TTNs?*' It begins with reviewing the overall aim and objectives of the research herein and a brief discussion of how the research question has been answered. It proceeds by discussing the contribution made by this research in increasing what is known about how older adults with multimorbidity using digital health technologies for health self-management can be supported by TTNs to engage in the process. The chapter continues with the discussion of the key findings (a detailed table of findings is found in Appendix N), which will be considered within the context of Hudon et al.'s (2011) PCC conceptual framework, a framework for patient-centred care which was used in this thesis to frame and elucidate the research conducted herein. This PhD's implications, its limitations and strengths, and future research directions will be discussed and the thesis draws to a conclusion with a closing statement.

8.1 Aims and objectives

The overall aim of the study was to examine the role of TTNs in supporting PwMs to engage in regular and sustained self-management of their health and well-being from home using digital health technology. The objectives were addressed as follows and are discussed in further detail in this chapter:

- **Objective 1:** *To review and critique the literature in relation to PwM engagement in self-management, including digital self-management, and to understand the role played by TTNs in supporting self-management*.

  A review of the literature related to the areas of multimorbidity self-management, TTNs support for self-management and PwMs' engagement with DHT was conducted. During the course of the review, three overarching themes for this study were developed which are: the self-management of health conditions, the role of the TTN in supporting PwMs, and the concept of patient engagement.

The key findings are:

  - Effectual self-management of health conditions requires human support which comes in the form of instrumental help (e.g., from HCPs with illness monitoring, shared decision making and discussions about self-management strategies), psychosocial support and emotional support;
  - Although there is a plethora of research into multimorbidity, there is little literature on the role that a nurse-led telephone triage service can play in supporting PwMs who are self-managing their conditions through the use of DHTs to engage in their self-management; and,
  - Patient engagement is increasingly being seen as vital in improving patients' health outcomes, quality of life, and as a way of reducing health care costs.

- **Objective 2:** *To explore how PwMs self-manage their conditions using DHT with TTN support, their motivation to self-manage, and the barriers they face with self-management*.

  To address this objective two separate but connected studies were carried out. The first was a qualitative study with 10 PwMs participating in the SMILE trial who had two or more of the following conditions: CHD, COPD, T2D, HTN and CHF and were using the ProACT platform and a suite of digital devices for self-management of their illnesses. The devices the PwMs received depended on their conditions (blood glucose monitor, blood pressure monitor, pulse oximeter) and all participants received a weighing scales and an activity watch for recording steps and sleep. Three TTNs working for Caredoc who provided the PwMs with support in the form of symptom monitoring, dealing with device alerts, and providing self-management advice and education, and one GP and one Practice Nurse who were both from the same GP practice were also interviewed. This exploratory study explored how TTNs supported PwMs to self-manage their multimorbidity through the use of DHT.

The second study comprised two parts. In Part 1 objective engagement data were collected from 64 participants who were participating in the SEURO trial and were also using the ProACT platform. Part 2 was a mixed methods exploration of the objective data and data from semi-structured interviews that were conducted with a sub-set of the 64 SEURO participants (n=24). These data were examined to determine the differences in engagement patterns between 12 PwMs who had TTN support to self-manage their conditions and 12 PwMs who did not have this support.

The key findings are:

- Both studies' participants took responsibility for their health by taking their readings and medications, adopting health behaviours such as adapting their diet and getting exercise, and using the CareApp and its features. The majority of participants followed the TTNs' advice perceiving it to be trustworthy. The PwMs appreciated having access to the TTNs because their advice either meant

    that they were able to avoid a GP visit or that they contacted their GP quickly before a health crisis occurred;
  - Several motivating factors were reported by the PwMs for self-managing their health. Chief among them were the TTNs' monitoring and health improvements; and,
  - Barriers to self-management that were identified by the participants included issues with the DHT such as devices not syncing with the iPad, equipment failures, and iPad updates not working and causing data loss, and for two PwMs in Study 1, health events were a barrier.
- **Objective 3:** *To identify the tasks undertaken by TTNs supporting PwMs to self-manage using a DHT and to explore the nature of the PwM/TTN partnership*.

  The TTNs used Netwell Admin to monitor symptoms and to respond to alerts generated by data collected from the PwMs in both the SMILE and SEURO trials. They made monthly check-in calls which were typically scheduled with the participants as well as additional calls when symptom alerts came into the system. The TTNs either marked the alerts as addressed (advice provided to PwM, alert resolved) or dismissed/discarded (for example, if the PwM took further readings that were normal). TTNs could also create notes in relation to alerts, visible by all TTNs on the team. PwMs' health and well-being data were also available, providing the triage team with a holistic picture of the PwMs' health before they called them to discuss an alert. The TTNs used humour, encouragement and simple advice as tools with the participants, which fostered not only holistic health care but also the PwMs' adherence to engagement with the DHT. As Study 1 took place during COVID-19, the

TTNs provided emotional support to the PwMs because they identified their loneliness and struggles with being separated from family and friends.

The nature of the relationship between the PwMs in both studies and the TTNs was collaborative and marked by mutual trust, excellent communication and good rapport. The TTNs took time to listen to the PwMs which was in sharp contrast to some of their experiences with their HCPs, hence the PwMs felt heard and valued which empowered them to self-manage their health, which in turn led to increased confidence and engagement in their own care.

The key findings are:

  - The TTNs provided a high level of practical support to both studies' PwMs through their phone calls, making referrals and dealing with the device alerts;
  - The TTNs' work to support the PwMs' engagement with the DHT was holistic, encompassing physical, psychological, emotional and social care for the participants, even though their interactions were conducted remotely; and,
  - The PwMs and TTNs in both studies developed a close bond despite having never met in person. The PwMs valued the TTNs' consistent contact and their availability to talk to them, unlike their own HCPs' interactions.

- **Objective 4:** *To examine whether a cohort of PwMs using a DHT with TTN support demonstrates different patterns of engagement with the DHT compared to a cohort without TTN support, and to explore the factors influencing these differences through qualitative data from both groups*.

  To address this objective, in Study 2, Part 1, objective engagement data from Netwell Admin were analysed to investigate whether there was any difference in the engagement with the DHT of the 64 PwMs who were participating in SEURO. This was achieved by exploring the data from the ProACT Plus TTN Support and ProACT No TTN Support cohorts. Further, in addition to the objective engagement data from Netwell Admin, the qualitative data for Study 2, Part 2, were collected through semi-structured interviews with the sub-set of 24 PwMs.

The key findings are:

- The objective engagement data from Study 2, Part 1 indicated that ProACT Plus TTN Support (with TTN support) engaged more than ProACT No TTN Support (without support) overall with the platform, the vitals monitoring, vitals devices, the CareApp and with most of the features (self-report, education, medication and goal setting features);
- ProACT No TTN Support met their activity goals on a higher average number of weeks than ProACT Plus TTN Support;
- The objective engagement data from Study 2, Part 2 highlighted that ProACT Plus TTN Support engaged more than ProACT No TTN Support overall with the platform, vitals monitoring, the CareApp and with the self-report, education and goal setting features;
- ProACT No TTN Support engaged very slightly more with the medication feature, and met their goals on a higher average number of weeks than ProACT Plus TTN Support; and,
- The qualitative data from Study 2, Part 2 suggested that older adults may be more inclined to engage with DHT when supported by TTNs. This could be related to the perceived quality of the relationship between them, which may contribute to PwMs feeling more motivated and confident to self-manage their

health. Their relationship was built on mutual trust and respect, open communication and was characterised as being friendly in nature.

This thesis proposed to answer the research question '*would older PwMs engage in regular and sustained digital self-management of their health without the support of TTNs?* Through a multiphase mixed methods approach, this study examined the role played by the TTNs in supporting PwMs to self-manage their multimorbidity. The findings demonstrate that the PwMs who did not have the support of the TTNs sustained the self-management of their health for the duration of their participation on the SEURO trial. However, their engagement with the ProACT platform was lower than that of the cohort of PwMs who had the TTNs' support.

8.2 This project's contribution to knowledge

There is much extant literature related to PwMs' engagement in the self-management of their health (Villalobos et al. 2020; Yang et al. 2019; D'Agostino et al. 2017; Ibe et al. 2017). In order to achieve better health outcomes, PwMs must be successful in the self-management of their multimorbidity which necessitates them to set priorities and make decisions daily (Bratzke et al. 2015). Yet there is little extant literature related to digital health care in multimorbidity and in particular, how multimorbid older adults can be supported to self-manage their health using DHT with the support of TTNs. Indeed, the type of telephone nurse monitoring described in this PhD was created for the two studies detailed here and has not been identified in the literature to the best knowledge of the PhD candidate. Hence, this is the first study to examine the phenomenon. Indeed, this study is the first large-scale multiphase mixed method study of its kind to examine the role that TTNs play in supporting older adult PwMs using DHT to self-manage their health.

In addition, this study captures how older PwMs engage with DHT to self-manage their multimorbidity and how they collaborate with TTNs to do this. Further, the nature of the relationship between the PwMs and the TTNs is explored. This exploration provides important insights into how support plays a significant role in enhancing multimorbid older adults' engagement with DHT and underscores the importance of social interaction in self-management success.

8.3 Discussion of findings

8.3.1 Introduction

In order to achieve better health outcomes, it is imperative that PwMs are successful in the self-management of their multimorbidity (McAleer et al. 2024; Audulv et al. 2011). This requires them to manage symptoms, treatment, emotional health and embrace lifestyle changes (Barlow et al. 2002). However, with the complexity of self-managing multimorbidity and the challenges multimorbidity presents, adherence to self-management routines for PwMs is inclined to be low (The Academy of Medical Sciences 2018). For older adults, these challenges are compounded by the ageing process (Liddy et al. 2014).

One way to support older adults to self-manage their health at home and facilitate increased patient-centred care is through the use of DHT (Doyle et al. 2022). Indeed, it has the capacity to promote active engagement in self-management of health and to create strong partnerships with HCPs (Mentis et al. 2017). The addition of human support from HCPs reinforces adherence to self-management (Nunes et al. 2016; Yardley et al. 2016; Liddy et al.

2014). PwMs frequently prefer support from their HCP with their self-management, rather than managing their conditions alone (Pichon et al. 2020; Chewning et al. 2012). Indeed, according to Pichon et al. (2020), self-management without such HCP support is undesirable and may be detrimental for the PwM. However, HCPs generally only see patients when an appointment is scheduled or when they need urgent medical attention because of a condition exacerbation (Doyle et al. 2019). In addition, HCPs are reluctant to review patient data, quoting a lack of time as the reason (Doyle et al. 2019; Morton et al. 2017). Given then that HCPs are unable, or perhaps are unwilling, to provide PwMs with the level of support to self-manage that PwMs wish to have, support from TTNs may provide an answer to this problem. The findings from both studies herein will be discussed using Hudon et al.'s (2011) PCC conceptual framework which provides a means to contextualise those findings. The four dimensions of this framework are: (1) patient-as-person; (2) bio-psychosocial perspective; (3) therapeutic alliance; and (4) sharing power and responsibility.

8.3.2 Patient-as-person

The first dimension of the PCC is patient-as person which encapsulates how a person experiences their illness. This dimension will be discussed in relation to the PwMs' experience of living with their conditions.

8.3.2.1 Living with multimorbidity

With old age comes the potential of living with multimorbidity, which may become the norm rather than the exception (Feather 2018). As has been discussed previously in this thesis, the effects of multimorbidity are wide-ranging and impact the physical, emotional and mental well-being of PwMs (Kandola et al. 2020; Read et al. 2017; Xu et al. 2017). Liddy et al.

(2014) characterise these impacts as building upon one another resulting in a bigger effect on daily life. The ten PwMs in Study 1 spoke about their experiences of living with multimorbidity such as experiencing pain, having difficulty walking, recovering from prolonged infections and taking large amounts of medication. In spite of the issues they dealt with on a daily basis, the participants appeared to cope well with their multimorbidity; for instance, two PwMs felt that their conditions were not a problem for them to deal with. Further, only one PwM spoke about the mental issues he experienced in coping with his illnesses.

While multimorbidity self-management is a lifelong undertaking (Lorig and Holman (2003), nonetheless, Liddy et al. (2014) argue that the presence of multimorbidity may actually improve a person's self-management of their health, which appears to be the case with the PwMs herein. This finding also echoes Scholz Mellum et al. (2019)'s findings who identified PwMs who both lived within their limits by continuing to live as usual and also 'lived with grit', i.e., they had a positive mental attitude and were determined to be in control of their illness management.

Previous research has pointed to the fact that PwMs frequently do not understand how to manage their health (Bratzke et al. 2015; Graffigna et al. 2014; Liddy et al. 2014). Despite Study 1's PwMs' apparent ability to cope, a lack of knowledge of how to self-manage conditions was evident in some participants, three of whom reported having a lack of knowledge related to either uncertainty about what their conditions were or having undiagnosed conditions, prior to taking part in the SMILE trial. The TTNs also spoke about this, discussing how some PwMs' self-management of their health had been less than optimal. For instance, they reported that PwMs had not been taking medications and they were unaware of the consequences of not doing so, or being unaware of symptom exacerbations. In contrast, a lack of knowledge about their conditions did not appear to be an issue for the majority of participants in Study 2, Part 2, with only one ProACT Plus TTN Support PwM reporting that he had not been as aware of his conditions before participating in SEURO. Instead, the other participants spoke about how they had coped well with their conditions prior to the trial and pro-actively self-managed their health through a combination of self-management behaviours.

The patient-as-person dimension of the PCC which emphasises the personal experience of illness was explored through the experiences of this study's PwMs. Despite their challenges, the participants showed resilience in dealing with their conditions and appeared to cope well. Further, knowledge gaps related to multimorbidity were reported in both studies by a minority of PwMs, which was more evident in Study 1. The findings underline the need for support, such as that provided by the TTNs, which empowers patients to seize control of their illnesses and guarantees good health outcomes.

8.3.3 Bio-psychosocial perspective

The bio-psychosocial perspective dimension of the PCC takes the whole person into consideration. It is not just about managing physical health, but also incorporates the person's psychological and emotional well-being, and the support needed to achieve improved health outcomes. The findings will now be discussed in relation to the dimension.

8.3.3.1 The experience of using ProACT to self-manage health conditions

DHT plays an important role in the effective self-management of chronic diseases, with its potential to overcome some of the difficulties patients experience in the health care system such as expensive health care which may be difficult to access and poorly synchronised (Chien et al. 2020; Villalobos et al. 2020; Liddy et al. 2014). Nonetheless, the digital self-management of chronic illness is a burdensome process for those who live with it. Patients with single illnesses have spoken of the chore of having to aggregate data from different self-management applications in order to be able to share it in an organised fashion with their HCPs (Pichon et al. 2020), and this burden is greatly amplified for people who manage more than one chronic illness. In contrast, in the qualitative findings herein, when speaking about the ProACT platform in general, the PwMs in Study 2, Part 2 (eleven PwMs from each cohort) were positive about the platform's usability. This was in spite of nine of the PwMs (ProACT Plus TTN Support=5, ProACT No TTN Support=4) not having had prior experience of using DHT. The objective engagement data from both parts of Study 2 underscores this, demonstrating that the PwMs in both trial cohorts engaged well with the ProACT platform. This suggests that they were empowered through the platform's usability to sustain the self-management of their health. However, ProACT Plus TTN Support engaged more than ProACT No TTN Support with the platform overall, vitals monitoring, the CareApp and most of it features (these findings are discussed further in Section 8.3.3.2 below) – particularly the self-report feature, which may be as a result of TTNs' encouragement to use it. This type of support for PwMs is important especially when for example, COPD symptoms such as breathlessness are not captured by devices. It is interesting to note that in both parts of the study, the ProACT No TTN Support PwMs met their activity goals on a higher average number of weeks than ProACT Plus TTN Support (9 vs 6.38, Part 1 and 11.50 vs 9.20 Part 2). This suggests that self-motivated participants can achieve activity goals without needing external support. Further, it may also be that the PwMs in this study are what Polak et al. (2025) characterised as 'the Independently Empowered' – those DHT user types who are characterised by their confidence in using DHT for self-management of their health and hence, are more likely to do so than less confident users of health technology.

In common with a number of the Study 1 PwMs, Study 2 Part 2's PwMs experienced difficulties with various aspects of the platform. For example, seven PwMs from each cohort had issues with the DHT, in particular with the devices such as the blood pressure monitor and smart watch. In addition, one Study 1 PwM and two Study 2, Part 2 PwMs (one from each cohort) voiced negative perceptions about the work involved in taking their readings, finding that taking their readings was a chore. Difficulties with DHT or negative perceptions of it have the potential to add to patients' treatment burden (Al-Zahidy et al. 2025). May et al. (2014) characterised treatment burden as the work involved in the self-management of illness and the impact that this has on quality of life. The consequences of adding to treatment burden include poor patient health outcomes, increased demand for health care services and rising costs of such services (*ibid.*). Patients can feel overwhelmed by needing to learn new technical skills, by the time taken to track symptoms, enter data, respond to app reminders or respond to alerts (*ibid*.). Further, technical difficulties may result in feelings of frustration or stress and constant reminders or alerts can cause anxiety (Al-Zahidy et al. 2025). This high rate of false-positive alerts is concerning, as it illustrates how overly sensitive alert algorithms may unnecessarily heighten participants' health vigilance and anxiety without improving safety outcomes. However, Arm 1 participants noted that the triage nurses' reassurance helped mitigate their concerns in relation to alerts, which may explain why all participants remained in the project for the full six-month period. On the other hand, Arm 2 participants received no triage support, meaning they were left to interpret the significance of alerts themselves. This may have increased worry or confusion and could have undermined confidence in the technology. Hence, these findings highlight the need for greater refinement and personalisation of alert thresholds to balance timely detection of genuine clinical issues with the minimisation of false alarms. Addressing this issue will be critical in future iterations of the technology to reduce the potential for unnecessary anxiety and alert fatigue among users. Finally, two PwMs from Study 2, Part 2 spoke about the trial being repetitive and tedious, but nonetheless were continuing their participation because they had committed to participating.

8.3.3.2 Monitoring and management as a motivator

Older PwMs require care that adopts a holistic approach that considers the physical, psychological and emotional well-being, and the social support required to achieve better health outcomes (Marengoni et al. 2011). The participants in both studies holistically self-managed their conditions by managing numerous illness parameters and felt motivated to do so. For instance, six of the PwMs in Study 1 reported being motivated to engage with using ProACT to self-manage their conditions because of the benefits they perceived they got because of taking their measures. These benefits included improved health behaviours such as exercising and eating healthier, and health improvements such as stabilisations in conditions and fewer infections. In fact, because they were happy with how they had benefitted from ProACT, nine of the participants were interested in continuing to use it after the SMILE trial ended.

For the 24 participants in Study 2, Part 2, they perceived that being proactive with their self-management by taking their measures and looking at their readings was important. It allowed them to learn about their conditions, provided reassurance and removed anxiety. Eight PwMs (ProACT Plus TTN Support=5, ProACT No TTN Support=3) also spoke about improved health behaviours, weight loss and improved health. The readings also gave instant accessibility to the PwMs' health statuses which removed the 'guess work' from their self-management. One PwM related that his readings helped him to talk to his HCPs and understand what they were telling him. Having the readings also meant that six PwMs (three from each cohort), knew when they had a spike in their conditions and whether or not they needed to see their HCP.

The objective engagement data from the health monitoring devices supported these findings revealing that the Part 2 PwMs on average took a total of 6,043 measures while in Part 1, the participants on average took a total of 14,106 measures. Further, in both parts of the study, ProACT Plus TTN Support PwMs took a higher average number of weekly measures than ProACT No TTN Support (290.19 vs 252.35 Part 1, 128 vs 104.42 Part 2). Only one device was used more by ProACT No TTN Support than ProACT Plus TTN Support which was the blood glucometer (n=12 vs 21 Part 1, n=5 vs 11 Part 2) which may be explained by the fact that ProACT No TTN Support contained a higher number of participants with T2D. However, when looking at the average number of blood glucose measures, this was higher in ProACT Plus TTN Support than ProACT No TTN Support (63.60 vs 50.90 Part 1, 73.60 vs 50.40 Part 2). This is interesting and suggests that the TTNs did indeed have an impact of the self-management behaviours of the ProACT Plus TTN Support participants.

The engagement with the vitals section of the CareApp where participants could review their readings, suggested a low level of engagement. In Part 1, both cohorts engaged with them for less than 50% of days and in Part 2, although the days engagement levels were higher, it still occurred on less than 60% of days. The level of measures taken by the PwMs when compared to their engagement with the CareApp and the vitals section may be because taking measures is required to be done either daily or several times a week, whereas opening the CareApp to look at the readings or engage with its features need not be done daily. In looking at number of measures taken by age group, in both parts of Study 2, it was participants from ProACT No TTN Support – the 65-74 years age group – who took the highest number of measures, but yet in Part 1 they engaged slightly less with the devices and in Part 2 engaged slightly more.

The findings demonstrate that self-management of health through DHTs is not just a clinical task but is an interplay of physical self-monitoring, emotional reassurance and social connectivity. They also highlight the fact that participants are individuals with unique experiences, preferences and contexts, all of which influence their engagement with the self-management of their health. Addressing these interconnected dimensions holistically is vital for engendering long-term engagement with DHT with the aim of improved health outcomes among older PwMs. The PwMs' were not just motivated to engage with the ProACT platform because of a desire to improve their health, but also because of the sense of comfort, reassurance and reduced anxiety that came from monitoring their own health metrics. Further, the TTNs' back-up for the PwMs in Study 1 and the ProACT Plus TTN Support PwMs in Study 2 reinforced this engagement, which was evident in both the qualitative and quantitative and data. This was because the PwMs appreciated their support and the connection they had with them.

8.3.4 Therapeutic alliance

This dimension focuses on the doctor-patient relationship, and the empowerment of patients by including them as partners in their health care management. The term therapeutic alliance describes the collaborative and trusting relationship between HCPs and their patients that supports effective and positive health outcomes. This section will discuss the findings herein in relation to this dimension of the PCC.

8.3.4.1 The relationship between the PwMs and TTNs

According to Liddy et al. (2014), the doctor-patient relationship is not always therapeutic, with contradictory information and poor access to HCPs being cited by patients as barriers to care. Two PwMs, one from Study 1 and one from ProACT No TTN Support in Study 2, Part 2 reported that they had faced challenges with their HCPs. The Study 1 PwM had a major issue with his hospital who misdiagnosed a serious heart condition which was captured by the TTNs who alerted him to it. Meanwhile, the ProACT No TTN Support participant had been left feeling vulnerable by an encounter with a hospital nurse who she perceived had been unwilling to fulfil her request to see a doctor. However, in both Studies 1 and 2, Part 2, the quality of the relationship between the PwMs and the TTNs was excellent overall, and it appeared to be a mutual partnership for the benefit of the PwMs. For instance, in Study 1 the participants and the TTNs spoke about having a close bond despite the fact that the relationship was conducted remotely. Indeed, one participant wanted to remain in contact with the TTNs after SMILE because of the rapport he had built with them. The TTNs in Study 1 experienced very few difficulties in dealing with the PwMs apart from needing to be persistent with some in getting them to go to their GPs, which they were reluctant to do because of COVID-19. In Study 2, Part 2 none of the 12 participants in ProACT Plus TTN Support experienced challenges in their interactions with the TTNs which they characterised as being supportive and friendly. This meant that the TTNs were able to build holistic relationships with the participants because of the nature of their exchanges, and they perceived that this enabled the PwMs to benefit more from the triage service.

Pywell et al. (2020) reported that a lack of face-to-face engagement is a major deterrent in engagement with DHT. The findings of both Study 1 and Study 2, Part 2 suggest that the PwMs sustained their engagement with ProACT because of the monitoring from the

TTNs. For instance, in Study 1, this was the most frequently cited motivator to use it, which was mentioned by eight PwMs. For instance, some felt that without having the TTNs to explain the reasons behind high readings, they would not be able to use ProACT. In Study 2, Part 2, five PwMs when asked about the TTNs' influence on their engagement with it, responded that they would use the DHT less if the readings were not being monitored. This was because they could see no point in taking readings if this was not happening, while conversely, one PwM felt she would use ProACT more because she would be more anxious without the support from the TTNs' monitoring.

8.3.4.2 The nature of the relationship

Research shows that frequently patients' dealings with their HCPs are rushed and unsatisfactory (Kuipers et al. 2021; Caldeira et al. 2021; Liddy et al. 2014). However, in the findings from both Study 1 and Study 2, Part 2, the PwMs noted that the TTNs spent a lot of time talking to them, something not experienced with their own HCPs. For example, in Study 1, one PwM reported that he preferred to speak to the TTNs about his health issues rather than his GP because of the time they spent in understanding his concerns. In Study 2, Part 2, one ProACT Plus TTN Support participant spoke about being rushed by her GP either when visiting the practice or on a phone consultation and how she felt that she needed to be quick in her dealings with them because they were so busy. This was also discussed by Study 1's Practice Nurse who was concerned by having a lack of time to spend with her patients. Participants spoke about being able to talk to the TTNs about topics other than their health, which was important particularly in Study 1 given that it took place during the COVID-19 pandemic. Knowing the PwMs on a deeper level meant that the TTNs were able to 'pick up on cues' when speaking to them which meant they could provide appropriate and holistic care. This was important as the participants were reluctant to attend their GPs during this period.

The objective engagement data from Study 2 revealed that over the 26-week period of their participation, 430 phone calls were made to the 32 ProACT Plus TTN Support PwMs in Part 1, and 147 calls were made to the 12 ProACT Plus TTN Support PwMs in Part 2. Of these, 238 to Part 1 PwMs and 72 to Part 2 PwMs were unscheduled, i.e., they were not the monthly ‘check-in’ calls. The participants in Study 2, Part 2 spoke about the importance of the calls in providing reassurance and security, especially if they had had an alert, of which there were 563 (428 of these related to blood pressure). Six PwMs felt that the calls alleviated their anxiety in the event of an alert and also removed the necessity to visit their GPs. For Study 1 participants, the level of contact with the TTNs increased confidence levels in their self-management capabilities, and like the Study 2, Part 2 participants, it also alleviated any concerns or anxiety they had health-wise. Both studies’ PwMs also discussed how they knew if they had a reading outside their normal range the TTNs would contact them. Indeed, the main outcome for the PwMs in both studies which was frequently mentioned was peace of mind as a result of the TTNs’ monitoring.

8.3.4.3 The TTNs’ role in supporting the PwMs

Relational support for the self-management of multimorbidity is the most important type of support (Dwarswaard et al. 2016) with PwMs ability to self-manage influenced by their social networks (Brown 2013; Vassilev et al. 2013; Schermer 2009). However, such support can add to the PwMs’ burden, as they may perceive it to be interference, lead to feelings of dependency, and they may feel compelled to have a positive attitude towards their illnesses (Dwarswaard et al. 2016). Therefore, this is where support from other sources such as the

TTNs can play an important role in PwMs' self-management. Positive patient-HCP relationships foster adherence to self-management (Yardley et al. 2016) as well as good health outcomes (Stewart et al. 1995). The high quality of the relationship with the TTNs resulted in the participants from both studies adhering to the self-management advice given to them which resulted in the positive health outcomes that were revealed in the findings herein. They followed the advice because they perceived the TTNs to be knowledgeable and the quality of the advice to be high. The advice given was not just related to using the DHT but was related to self-management behaviours as noted by one Study 2, Part 2 participant who recalled the TTNs' insistence that he should have 24-hour blood pressure monitoring done by his GP because they were concerned about it.

From the TTNs' perspective, they felt that the high level of trust they had built with the PwMs in Study 1 meant that they had a good rapport with them, resulting in the advice they gave being followed. They used strategies such as humour, keeping the advice simple and encouragement to keep the participants self-managing. However, there is evidence that when patients know that their symptoms are being monitored, there is the potential for a reduction in self-management behaviours (Doyle et al. 2021). This happens especially in the event of an out-of-range reading as the patient becomes reliant on the person monitoring them (Morton et al. 2017). This was not apparent in Study 1, but in Study 2, Part 2, one ProACT Plus TTN Support participant did not look at his readings because he knew that the TTNs would contact him if there was a problem, likely as he did not see a need to monitor them for himself.

Study 1 participants felt motivated to self-manage because they knew their readings were monitored by the TTNs who would contact them if they did not take them for a few days. They viewed this as positive and did not report feeling apprehensive about being monitored. Conversely, the ProACT Plus TTN Support PwMs in Study 2, Part 2 did not mention this as a motivator, but five of them perceived that if they did not have the TTNs' monitoring, they would use the DHT less often. Other motivators mentioned by the Study 2, Part 2 participants were contributing to research (ProACT Plus TTN Support=6, ProACT No TTN Support=5) for reasons such as taking part in a Europe-wide research project, contributing to knowledge and the possibility of a cure for one ProACT No TTN Support participant's COPD. Further, wanting to help others was a motivation, even for the three PwMs (ProACT Plus TTN Support=1, ProACT No TTN Support=2) who did not feel they benefitted from the DHT.

The findings across both studies highlight the strong therapeutic alliance that existed between the participants and the TTNs. Unlike many health care relationships, theirs was described by both parties as being supportive, collaborative, respectful and trusting. Previous negative experiences with HCPs were described which left some of the PwMs feeling unheard. In contrast, their relationships with the TTNs were positive, with the TTNs giving the PwMs time to talk which resulted in the PwMs feeling heard and cared for, even though their interactions were conducted remotely. The regular contact from the TTNs provided the participants with peace of mind about their health. The TTNs spoke about their approach with the PwMs which included humour, encouragement and keeping their advice simple, tactics which ensured that the participants adhered to self-management behaviours. The therapeutic alliance that was fostered between the PwMs and the TTNs led to better engagement with ProACT and positive health outcomes.

8.3.5 Sharing power and responsibility

The final dimension of the PCC emphasises mutual trust, respect and communication between patient and doctor which becomes the bedrock of effective care.

8.3.5.1 Common ground

Patient-doctor relationships are not always equal because traditionally they were based on a paternalistic/authoritarian model where the patient passively received treatment given by their doctor (Odero et al. 2020). This is changing as health care becomes more patient-led, yet issues exist in the relationship between doctors/HCPs and patients (Topol et al. 2015). The issues that patients have identified include the need for mutual trust and respect, the need to feel listened to, wanting to be able to ask questions and have them answered, and to have their emotional well-being monitored (Odero et al. 2020; Liddy et al.2014).

ProACT helped the PwMs from both cohorts (ProACT Plus TTN Support=6, ProACT No TTN Support=10) in Study 2, Part 2 to establish common ground with their HCPs because they spoke about being able to discuss their readings with their GPs either in person or on the telephone, which helped allay their concerns when the readings were outside their normal ranges. Further, it is evident that in the relationships between both Study 1 and Study 2, Part 2's participants and the TTNs, these were not issues that occurred, as they were built on reciprocal trust and respect. The PwMs in both studies felt that the TTNs were interested in them on a personal level, because their conversations were about more than their readings, which the PwMs appreciated because they felt able to speak about anything to the TTNs. In Study 1 the TTNs' also spoke about having such conversations which they felt built rapport and trust with the PwMs and was important because it enabled them to deliver appropriate care and ensured that their advice was followed. The PwMs followed the advice given to them by the TTNs because they both trusted and respected the TTNs, and also what they were being told. Yardley et al. (2016) argue that human support is particularly important when DHT users need emotional support and reassurance. The TTNs recognised the toll that the pandemic was taking on the PwMs and provided them with emotional support, having witnessed the impact that being separated from their families during lockdowns had. Finally, the collegial nature of the relationship between the Study 1 participants and TTNs meant that the PwMs took responsibility for their own health by using ProACT because they felt a sense of duty towards the TTNs.

In Study 2, Part 2, the participants spoke about having confidence in the advice given by the TTNs which consequently, imbued them with confidence to self-manage their conditions. Indeed, such was his confidence in the TTNs, one PwM said he would contact them before contacting his GP. The PwMs also felt listened to because the TTNs did not rush the phone calls, which one PwM thought would be important for an older adult living alone. In addition, the PwMs felt well supported by the TTNs because they asked questions about their general well-being. Of note, four of the PwMs said that having their questions answered by the TTNs was not important to them as they were managing their conditions sufficiently, while two PwMs said they would prefer to have their health queries answered by their HCPs.

While traditionally patient-doctor relationships were paternalistic with doctors holding most of the power, this was not the case for the PwMs in this study. They experienced collaborative and equitable relationships with the TTNs, marked by reciprocal trust and excellent communication and meant that they felt heard and valued, which empowered them to self-manage their health.

The findings demonstrate that by sharing power in health care relationships through building trust, actively listening and treating patients as equals, this leads to shared responsibility for good health outcomes. Patients are more likely to take ownership of their health and actively manage their conditions if they feel respected, and the respectful and collaborative partnership between the participants and the TTNs ensured that this occurred for the PwMs in this study.

8.3.5.2 Engaging with the ProACT platform and the health care features

Previous research into engagement with DHT demonstrates that dropout rates and non-usage attrition are higher without human support (Yardley et al. 2016), and that without support from HCPs for example, the burden of self-management is increased (Dwarswaard et al. 2016; Meranius and Hammar 2016; Maneze et al. 2012). Despite encountering issues with the DHT which they found frustrating, none of the 10 Study 1 PwMs reported that they had stopped using the ProACT platform during their time on the trial for this reason. They were pleased with the response of the technical support team who responded quickly to resolve them and were also appreciative of the TTNs’ assistance with getting the technical team to contact them when necessary. Two PwMs temporarily disengaged from using ProACT because of health issues and another stopped taking his blood sugar readings because of the expense of buying lancets, but continued taking his other readings. Additionally, satisfaction with the SMILE project meant that the eight participants who reported health stabilisations continued with their participation.

The objective engagement data from both parts of Study 2 align with Yardley et al.’s (2016) findings, i.e., ProACT Plus TTN Support engaged more than ProACT No TTN Support with the platform overall. While the difference in engagement between the cohorts is comparable, nonetheless it suggests that the TTNs' support did promote better engagement with the DHT, and that when responsibility for self-management is shared there is a positive influence on engagement. ProACT Plus TTN Support PwMs in Part 1 engaged more on average than ProACT No TTN Support (75.22% vs 73.91% days engaged), which was also true of the sub-set of 24 participants (83.92% vs 78.67 days engaged). In addition, in Part 1, ProACT Plus TTN Support's participants engaged with the CareApp (opening it) more than ProACT No TTN Support (54.16% vs 46.10% days engaged) and this was also the case in Part 2 (61.67% vs 57.08% days engaged). By age group and in both study parts, interestingly, for two of the age groups (65-74 years and 75-84 years age groups) the ProACT No TTN Support PwMs engaged more with the CareApp than ProACT Plus TTN Support, with the only ProACT Plus TTN Support PwMs who engaged more than ProACT No TTN Support being in the 85+ years age group (87.25% vs 52.33% days engaged). Further these were the highest and lowest levels of engagement across age groups and cohorts. However, these findings should be interpreted cautiously due to the small sample size in this age group (seven PwMs in total and three in the sub-set).

In contrast, the qualitative findings in Study 2, Part 2 appears to contradict both Yardley et al.'s (2016) findings and the objective engagement data, because more ProACT No TTN Support PwMs than ProACT Plus TTN Support PwMs (12 vs 11) reported that they were taking their readings at least once daily. Further, again, more ProACT No TTN Support PwMs than ProACT Plus TTN Support (10 vs 9) reported that their levels had not changed since commencing the trial, while three PwMs reported that their engagement had changed. Of the three participants, one ProACT Plus TTN Support PwM stated that he was using ProACT less and when asked why, gave no reason for this. Interestingly, again it was two ProACT No TTN

Support PwMs who reported that they were using it more frequently, because they both stated that they felt that they benefitted from using the DHT.

In looking at the objective engagement data and the engagement with the CareApp's features – the activity, self-report, education and medication features, the objective engagement data from Study 2, Part 1 reveal that ProACT Plus TTN Support engaged with them more than ProACT No TTN Support, with the medication feature being the most used. Previous research has found that having a person who monitors readings and draws attention when inconsistencies occur increases engagement with DHT, which this finding suggests (Lenferink 2017; Morton et al. 2017). However, notably the medication feature was used more by Study 2, Part 2's ProACT No TTN Support cohort (26.42% vs 24.17% days engaged), although the difference in usage is very small. Meanwhile, the education feature was the least used feature in both parts of Study 2. In Study 2, Part 1 this was on 3.50% of days for ProACT Plus TTN Support and 2.19% of days for ProACT No TTN Support, while in Part 2 this was slightly higher, being on 4.50% of days for ProACT Plus TTN Support and 2.42% for ProACT No TTN Support. This is surprising given that a lack of knowledge is frequently cited as a barrier to good self-management of health (Bratzke et al. 2015; Graffigna et al. 2014). However, the qualitative data from Study 2, Part 2 reveals that the education feature was only accessed by 10 participants (ProACT Plus TTN Support=6, ProACT No TTN Support=4) and of those who did not access it, five PwMs (ProACT Plus TTN Support=3, ProACT No TTN Support=2) said that they were unaware of it. This may be due to a wariness to explore the CareApp more fully or due to the PwMs needing more training on using the ProACT platform.

In both parts of Study 2, ProACT Plus TTN Support PwMs completed more self-report surveys, and in Part 1, the difference in numbers was significant (2,636 vs 1,403), whereas in Part 2, the difference was smaller (1,353 vs 863). ProACT Plus TTN Support in both parts of the study on average completed more self-reports each week than ProACT No TTN Support, with a greater number being completed by the sub-set of 24 PwMs in Part 2. Perhaps this was not surprising as more than half of the PwMs reported that they completed the surveys (ProACT Plus TTN Support=6, ProACT No TTN Support=7). What is surprising is the fact that more ProACT No TTN Support PwMs reported that they completed the surveys, when the objective engagement data shows that they actually completed less than their ProACT Plus TTN Support counterparts. This suggests a dissonance between what participants perceive and what objective engagement data reports. The discrepancies between the objective engagement data and that which came from the qualitative interviews highlights the nuanced reality of self-management where a participant's recall of effort and routine differs from objective data. While this may appear problematic when the 'ideal' is seen as having findings that confirm the findings from one method with those of another, in fact, having findings that are discordant provides researchers with the opportunity to understand complex phenomena (Wagner et al. 2012).

Regarding the self-report survey completions by age group, in all age groups and both cohorts a number of PwMs did not complete any surveys, an issue that has been discussed in previous research (Sheng et al. 2022). This occurs because older adults not only find them cognitively burdensome to complete, but they also place a low value on their worth (*ibid*.).

In relation to the activity goal setting feature, more goals were set by ProACT Plus TTN Support PwMs in both parts of Study 2, again suggesting that having support and sharing responsibility for self-management leads to increased engagement with DHTs. Notably, In Part 2, nine PwMs set goals (ProACT Plus TTN Support=5, ProACT No TTN Support=4), yet in the semi-structured interviews the number of PwMs who reported that they had set a goal was seven (ProACT Plus TTN Support=4, ProACT No TTN Support=3). This again reveals a difference between what the participants and objective engagement data reported. In looking at the goals set by trial cohort and age group, in both parts of Study 2, the small number of participants who set goals and the low number of goals they set, especially in the older age groups, points to the impact that multimorbidity has on PwMs' ability or inclination to exercise. These include pain, fatigue, breathlessness, lack of motivation, and lack of confidence particularly in the oldest-old (López-Novis et al. 2024; Jäger et al. 2022). For the PwMs in this study who did not use the feature, the reasons given were either not being physically able to take exercise or they were uninterested in goal setting as they felt they got enough exercise. This PhD continues with a discussion of the implications of this PhD's findings.

8.4 Implications of this project's findings

This research study contributes to a greater understanding of how older PwMs using digital health technologies for health self-management can be supported by TTNs to engage in the process. However, multimorbid older PwMs rarely have access to the type of holistic care that the TTNs provided the participants in this study with. Lorig and Holman (2003) argue that the self-management of multimorbidity is a lifetime undertaking and this is especially true for PwMs as they get older, as old age brings with it its own difficulties. Older PwMs' self-management increases in difficulty as the ageing process potentially leads to conditions such as eye problems, hearing loss, memory loss and mobility issues (WHO 2022). Their health care requires appointments with a variety of health care providers who frequently dispense conflicting health advice (Feather 2018; Slattery et al. 2017).

The findings herein highlight that the PwMs were empowered to self-manage their health through using ProACT, and for ProACT Plus TTN Support participants more so because of the TTNs' support. The findings also illustrate that older PwMs will use DHT for the self-management of their conditions, especially if they have human support such as that from TTNs as is the case in this study. Indeed, the 85+ years age group while small in number – one PwM in Study 1, seven in total in Study 2, Part 1 (n=4 ProACT Plus TTN Support, n=3 ProACT No TTN Support) and three in total in Study 2, Part 2 (n=2 ProACT Plus TTN Support, n=1 ProACT No TTN Support) – engaged well with ProACT and sustained their engagement throughout their time on the trial. For instance, the objective engagement data revealed that in both parts of the study ProACT Plus TTN Support's cohort had the highest level of engagement with the ProACT platform and engaged the most across all groups with the education feature.

There is a shift in Irish health care to digitalisation which is intended to address the staffing shortages, control expenditure and ultimately, improve health outcomes (Department of Health 2024). However, this has implications for older PwMs who can struggle with DHT because of the ageing process and also with DHT itself (O'Reilly et al. 2022; Wilson et al. 2021; Nymberg et al. 2019). Further, Western et al. (2025) argue that digital health interventions tend to benefit more privileged groups, i.e., those who because of their socio-economic background, educational status, living location or younger age, have the opportunity to use DHT. This digital health divide, defined by Hall et al. (2014) as the gap between those who access and use health information technology and those who do not, is prevalent in vulnerable populations, and older adults are particularly vulnerable (Czaja et al. 2013; Anderson 2010). This is because their technology use is limited by a lack of access to and/or a lack of experience using it, and an increased occurrence of chronic illnesses (Czaja et al. 2013; Anderson 2010). This may result in the loss of access to timely health care and therefore, it is essential that the digital health divide is addressed to ensure that those who could benefit most from it have the opportunity to do so (Western et al. 2025).

To address this, governments must adopt a multi-faceted approach that prioritises equity in digital health. This includes investment in affordable broadband and device access**,** particularly in rural and underserved areas; provision of digital literacy training tailored to older adults and those with low baseline technology skills; and development of inclusive service models that combine digital tools with accessible human support, such as that provided by the TTNs in this study. In addition, policies should require that DHTs are co-designed with vulnerable user groups to ensure usability and accessibility. Without these measures, there is a real risk that the drive towards digitalisation in healthcare will exacerbate, rather than reduce, existing health inequalities.

8.4.1 Implications and recommendations for practice

With the global population of older adults rising, and hence, the population of multimorbid people also increasing, health care systems are increasingly under pressure in terms of finances and staffing. For instance, the Irish population of people aged 65+ years has increased by 28% since 2016 which is putting pressure on an already heavily burdened health care system (Department of Health 2024). As reported in Chapter 1, in Ireland the health service faces a deterioration in working conditions and a shortfall in staff as HCPs either move abroad for better working conditions or retire (IHCA 2020; Hayes et al. 2019; Humphries et al. 2018). Further, in the EU, the shortfall in staff (doctors, nurses and other HCPs) is projected to reach 4.1 million people by 2030 (WHO 2016).

The findings in this PhD are important for future health care service delivery, which aims to decentralise care to the community. With the move to community health hubs, triage nursing will be important in ensuring that patients are directed quickly to appropriate care, thus ensuring that potentially limited health resources are optimised. As health care is also transforming to digital care some recommendations are:

- Governments should develop digital health policies that include older PwMs by ensuring they have affordable access to DHT. This could be by providing reimbursement schemes that would encourage them to purchase a DHT, instigating training programmes that increase both digital and health literacy, and investing in vital infrastructure such as reliable broadband;
- HCPs should incorporate DHT into their practices by prescribing wearable devices for example; and,
- Given potential challenges in implementing TTN support at scale such as its cost, and the recruitment of suitably qualified and experienced TTNs, there is a need to identify the types of PwMs who will benefit most from it. This will prevent a wide roll-out to individuals who do not need it and put the focus on those who do.

8.5 Limitations and strengths

The first limitation of this PhD project is that interviews in both studies were conducted by telephone, which meant that the researcher could not read the participants' body language and therefore cues could not be picked up, which may limit interpretation of the data. Further, telephone interviews mean that it is harder to build rapport and establish trust between researcher and interview subject (Irvine et al. 2020). However, this method of data collection was made necessary because Study 1 took place during the COVID-19 pandemic. In addition, the distance from the PhD candidate's work place in the North-East of

Ireland allied with the wide geographic spread of the participants in the South-East underscored the need to use this method. In Study 2, Part 2 telephone interviews were used because of the wider geographic spread of the participants than those in Study 1, in the East and South-East of Ireland and as in Study 1, the distance from the PhD candidate's work place. Nevertheless, the data from the telephone interviews were high quality, providing data that were a rich source of information related to how TTNs' support PwMs to self-manage their health using DHTs. The interviews provided valuable insights into how older PwMs are empowered to use DHT when they have human support, namely that from TTNs.

Another limitation is the modest number of participants in Study 1, and also the fact that four of the PwMs who were recruited by Caredoc were not 65 or over, as requested by the PhD candidate. These issues arose as a result of the impact that COVID-19 had on this study in terms of the difficulty in recruiting appropriate participants. Hence a pragmatic decision was made to proceed with including in the study the PwMs that Caredoc were able to recruit.

A further limitation is the small number of participants aged 85+ years. The age groupings were retained in the descriptive analysis to reflect established demographic categories commonly used in ageing research (i.e., 65–74, 75–84, and 85+ years) and to account for the heterogeneity of digital health engagement among older adults. Although the number of participants aged 85+ years was small, retaining this category allowed for exploratory insight into the engagement patterns of the oldest-old, a population increasingly recognised as facing distinct challenges with technology use and digital health. Prior studies have demonstrated that individuals aged 85+ years are significantly more likely to lack access to internet-enabled devices, possess limited digital literacy, and experience physical or cognitive barriers that hinder their participation in digital care. For instance, Lam et al. (2020)

reported that 72% of U.S. adults aged 85+ years were considered unready for telehealth due to combined functional, cognitive, and technological limitations, compared to just 25% of those aged 65–74. Similarly, Alhussein et al. (2023) found that only 38% of Americans aged 85+ years had internet access, compared to 70% in the 65-74 years age group. This highlights the value of retaining the 85+ years age group in this study to ensure visibility of a demographic often underrepresented in digital health evaluations and to inform future research on tailored supports for this cohort.

The final limitation of this PhD project is the small number of TTNs involved in delivering support within both SMILE and SEURO. Support was provided by a consistent but small TTN team, which allowed for continuity and in-depth engagement with participants. However, this also means that findings related to trust, communication style, and engagement may reflect individual nurse characteristics as much as the intervention model. As such, the generalisability of findings is constrained; different TTN teams or less experienced providers may not replicate the same levels of participant reassurance or sustained engagement observed in these studies. Future research should consider the influence of individual practitioner characteristics and evaluate triage models across diverse staffing contexts to assess scalability and implementation fidelity.

One strength of this study is the research design that was used. Self-reported data carries the risk of biases such as ‘social desirability bias’ – i.e., where the participant may answer a question in a way that they feel is socially acceptable – or memory recall bias, where the participant misremembers past events (Spitzer and Weber 2010). This study uses a multiphase mixed methods research design which has the benefit of combining qualitative and quantitative research that is interconnected and has been conducted over time. Evaluating engagement with DHT can only be understood through a comprehensive means of assessment such as mixed methods research (Laurie and Blandford 2016). Adopting such a research approach provides a better understanding of how effectively users are in engaging with DHTs (Yardley et al. 2016). While quantitative research quantifies data, qualitative methods, which capture how and why something happens, can be used to explain objective data. The second strength is that the research focus of this study is with an understudied cohort – older adults with multimorbidity. It provides unique insights into how they used the DHT to self-manage their health with the support of TTNs.

8.6 Future research

There is scope for future work to further the research presented in this PhD thesis. Given the short time-frame of the PwMs' participation in Study 2, collecting data over a longer period of time would provide researchers with an opportunity to better capture changes in health conditions and self-management behaviours in PwMs with and without TTN support through adopting a before and after research design (Polit and Beck 2006). In addition, a larger scale trial with more participants is warranted to confirm the findings from the two studies presented in this thesis.

In addition, future work could explore what is needed to establish the optimal way to integrate DHT with TTN support. For instance, investigating in greater detail symptom stabilisation and what level of engagement is required for different individuals to ensure that their engagement with DHT is effective, as higher levels of engagement may not always be better if health outcomes do not improve. This research would then provide a better understanding of the level of support required in order to promote effective engagement with DHT.

Finally, while enhancing patient engagement through human support – such as TTN-led interventions – can significantly improve self-management and adherence to care plans, it is crucial to weigh this benefit against the need for scalable, cost-effective health care solutions. Human support, though valuable, may not be feasible for widespread implementation in resource-limited systems over the long term. Therefore, sustainable service models must consider hybrid approaches that optimise the use of human resources by deploying nurse support strategically – only when clinically necessary or most impactful. Future research should therefore explore the effectiveness of intermittent or on-demand nurse interactions, assessing whether these targeted interventions can deliver outcomes comparable to continuous support. Such evidence will be key to determining whether hybrid care models can strike the right balance between maintaining high-quality patient engagement and ensuring economic viability. Ultimately, understanding this trade-off is essential for the design of DHTs that are not only clinically effective but also scalable within financially constrained health care environments.

8.7 Concluding remarks

There is no doubt that living longer is a cause for celebration as it allows people to have more time to achieve personal goals, spend time with family and friends, and provides more opportunities to learn, grow and contribute to society. However, this achievement is somewhat mitigated by the fact that people are not necessarily living healthily into advanced old age. Multimorbidity is on the increase because of an ageing population and may become the norm rather than the exception (Feather 2018). Further, multimorbidity places a considerable financial burden on health services, with €700 billion being spent annually on chronic illnesses in the EU (Brennan et al. 2017). This illustrates the need to find a solution to these issues and one solution may lie in providing PwMs with DHT to self-manage their conditions. Moreover, as engagement with DHT is more successful when human support is in place, the solution to this may be having TTNs to monitor readings, address symptom alerts and provide advice to PwMs.

Living with multimorbidity compels people to feel that they are ‘living an illness’ (Liddy et al. 2014), hence it is important to recognise that PwMs are more than people who are ill. The TTNs did this, and in doing so treated the PwMs as collaborators in their health care, not just passive recipients of care. The self-management of multimorbidity is a lifetime undertaking (Lorig and Holman 2003), therefore it is crucial to support PwMs to achieve optimum health, particularly PwMs who are older. The findings herein highlight how the TTNs supported the participants through consistent, patient-centred interactions that created a space where the PwMs felt safe, supported and respected, and thus empowered them to take control of the self-management of their health. The findings also demonstrate how remote technology-based health care can provide PwMs with a strong therapeutic connection once it is grounded in respect, trust and empathy.

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Appendices

Appendix A: Participant information leaflet (PwM)

Study title: The role of nurse-led telephone triage in supporting people with multimorbidity to digitally self-manage

Researcher Name: Patricia McAleer

You are being invited to take part in a research study to be carried out by Dundalk Institute of Technology (in partnership with Caredoc and Trinity College Dublin).

Before you decide whether or not you wish to take part, you should read the information provided below carefully. It is important that you do not feel rushed or under pressure to decide whether to take part. If you have any questions, you can contact me at the number above.

You should clearly understand what's involved in taking part in this study so that you can make a decision that is right for you. This process is known as 'Informed Consent'.

You can change your mind about taking part in the study at any time. Even if the study has started, you can still opt out. You don't have to give us a reason. If you do opt out, rest assured that there will be no negative consequences for you.

Why is this study being done?

This study is taking place to find out the role played by a triage service in supporting people with multiple chronic conditions to digitally self-manage their symptoms and well-being through using the ProACT system. This study is part of a larger study, namely the SMILE project being carried out by Caredoc, in partnership with Dundalk Institute of Technology and Trinity College Dublin. As part of the SMILE project, you are involved in using the ProACT system to self-manage your conditions at home and are being monitored by triage nurses in Caredoc. This particular sub-study is being carried out to understand the role played by triage in supporting you with your self-management and to ask you about your experiences using the technology.

Who is organising and funding this study?

This SMILE study has received funding under the Slaintecare Integration Fund.

Why am I being asked to take part?

You are being asked to participate in this portion of the study, as you have been referred by your GP or Practice Nurse to use the ProACT system.

How will the study be carried out?

This study will take place at the end of the ProACT trial period. You will have been using the ProACT system for a number of months at this point.

We will ask you to complete a brief demographic questionnaire. We will also ask you to take part in an interview with a researcher at the end of the study. For this study, we are interested in finding out your opinions about this system, how you used it, whether this type of information was useful to you in the self-management of your health and your perceptions on the role played by the triage service in supporting you to self-manage. We will also ask you about your experience in using the system and having access to the triage service during the COVID-19 pandemic and how you found managing your conditions during this time.

What will happen to me if I agree to take part?

If you agree to take part, you will be a participant in the study as described in the previous section. The researcher will contact you to determine a place and time that suits you to take part in an interview or focus group. This will take up no more than one hour of your time.

Participation in this study is completely voluntary – you can withdraw at any time and you are free to decline to answer some or all of the questions asked to you. You are also entitled to withdraw your data from this study if you wish. You can request your information to be withdrawn from the study at any time, up until the point where it has been completely anonymised and is no longer able to be linked to you, or it has been included anonymously in a publication of research results.

What are the benefits?

There are no particular benefits to your participation. Your participation in the study will inform our research and help us to better understand and improve the way technology such as ProACT can be used in practice. This will be of benefit to others in the future who might use such technologies.

What are the risks?

There are no risks associated with this study.

What if something goes wrong when I'm taking part in this study?

We don't expect that anything will go wrong during the study. You will just be requested to take part in a focus group or interview for approximately one hour.

Is the study confidential?

Your identity will remain confidential at all times. The information that we collect from you during this study will be stored securely.

You will be assigned a unique study ID code, and the information that you provide during the study will be stored under this ID code, separately from your name or other identifying information. Only the researchers listed at the end of this leaflet will be able to link your name with this ID code and your data.

We will use results from the study in research reports, a PhD thesis and publications but we will never use your name or other identifying information in these. We are happy to share the findings of the study with you, once the study has ended and the information collected has been analysed.

We will not keep the information collected during the study for more than 5 years. After this time, we will ensure all information is destroyed. This is in line with Data Protection Legislation.

Where can I get further information?

If you need any further information now or at any time in the future, please contact:

Name: Patricia McAleer

Address: NetwellCASALA Research Centre on Ageing**,** PJ Carroll's Building, Dundalk Institute of Technology, Dublin Rd.

Appendix B: Participant consent form for PwMs

Study title: The role of nurse-led telephone triage in supporting people with multimorbidity to digitally self-manage

I have read and understood the Information Leaflet about this research project.	Yes ☐	No ☐
The information has been fully explained to me and I have been able to ask questions, all of which have been answered to my satisfaction.	Yes ☐	No ☐
I understand that I don't have to take part in this study and that I can opt out at any time. I understand that I don't have to give a reason for opting out.	Yes ☐	No ☐
I understand that my identity will remain confidential. The results will not be linked to my name in any way and any information about me will be securely stored in an anonymised record.	Yes ☐	No ☐
I have been given a copy of the Information Leaflet and this completed consent form for my records.	Yes ☐	No ☐
Storage and future use of information: I give my permission for information collected about me to be stored or electronically processed, for the purpose of this research.	Yes ☐	No ☐
I give my permission for information collected about me to be stored or electronically processed for use in related studies or other studies in the future but only if the research is approved by the original Research Ethics Committee or its replacement.	Yes ☐	No ☐

Participant Name (Block Capitals) | Participant Signature | Date

To be completed by the Researcher:
I, the undersigned, have taken the time to fully explain to the above participant the nature and purpose of this study in a way that they could understand. I have explained the risks involved as well as the possible benefits. I have invited them to ask questions on any aspect of the study that concerned them.

---Name
(Block Capitals) | Qualifications | Signature | Date

Appendix C: PwM interview protocol

1: General introduction questions-

What interested you in taking part in the SMILE project?

Before SMILE, can you tell me what were the challenges that you had to deal with in managing your conditions?

2: SMILE-

1. What do you think have been the main benefits for you as a result of being involved with SMILE?

2. Did you have any challenges in using the ProACT technology (the devices or the application)?

If yes, what were those challenges?
How did you overcome those challenges?

3. Did having the technology make any difference to the way that you self-manage?

If yes, what were those differences?

4. Would you be interested in using this type of technology in future, after this trial ends?

5. Do you think that the technology helped you to self-manage your conditions?

If yes, in what way?

6. Have you been more motivated to self-manage your conditions because of using the technology?

If yes, in what way?

3: Relationships-

1 How would you describe your relationship with the nurses in Caredoc?

2. What is the most important aspect of your relationship with the triage nurses?

3. Have you had any difficulties in dealing with the nurses?

If yes, what are those difficulties?
How do you deal with those difficulties?

4: Supports-

1. What types of support do you get from the nurses to self-manage?
2. What do you think is the most important support you get?
3. Why do you think that?
4. Has having the support of the triage nurses motivated you to self-manage your conditions better?

If yes, in what way?

5: Advice received-

1. When you get advice from the nurses, do you always follow it?

If no, why is that?

2. If you don't take the nurses' advice, what do you do instead?

3. If you haven't followed their advice, have you regretted your decision?

6: Covid-19-

1. Did COVID impact on the way you usually access care? For example, did it impact whether you accessed your GP, any of your consultants?

2. What has been the impact of Covid-19 on how you self-manage your conditions?

3. Has using the ProACT technology during Covid-19 had an impact on how you self-manage?

If yes, what are those impacts?

4. What has having access to the triage nurses during COVID been like for you?

7: Access to triage-

1. Has having access to the triage nurse service impacted how you self-manage?

If yes, in what way?

2. Has there been any benefit to you in having access to the triage service?

If yes, what have those benefits been?

3. We're hoping the SMILE trial will continue. But would you be willing to pay for a triage service in the future after this trial ends?

Finishing up-

Would it be ok if I contacted you again if I had any follow up questions?

Appendix D: TTN focus group interview protocol

1: SMILE triage-

1. Prior to taking part in SMILE, are you aware of what challenges participants may have had in self-managing their conditions?

2. What are the benefits of a programme like SMILE to patient self-management?
    - Is this because of the participants using the tech, having triage support or both?

3. What do you think is the added-value that you bring to people self-managing with technology?

2: Relationships-

1. What do you think is the most important aspect of having a good relationship with the SMILE participants?

2. Can you tell me how you build a good relationship with them?

3. If you have difficulties in your relationships, how do you deal with those difficulties?

3: Supports-

1. What are the types of support that you give to the SMILE participants?

2. What do you think is the most important support that you provide them with and why do you think that?

3. How do you provide those supports?

4. Do you think that having the SIMS data helped you in your role in providing support to PwMs?
    - If yes, in what way?

5. Does the SIMS data help you with tasks such as making assessments, making referrals, making follow up calls?

6. Does the SIMS data help you with providing support to the participants such as giving encouragement; providing education and enabling their learning?

4: Advice given to SMILE participants-

1. In relation to SMILE participants, how do you determine the advice that you give?
    - For example, is it through looking at the data or is it by talking to the person?
    - Or is it generic advice based on the person's conditions, taking into account all of their conditions?

2. Do patients always understand the advice that you're giving to them?
    - If they don't, why do you think this is?
    - How do you deal with that?

3. Do you find that some patients don't follow the advice that you give?
    - Would this happen a lot?
    - Why do you think that patients don't follow your advice?

4. What do you do about it?
    - Do you keep a record of this?
    - Do you follow up with those patients?

5. When a patient doesn't follow your advice, how do you feel about this?
    - Does this have an impact on you?
    - If it does, what is the impact?

6. Do you advise patients in relation to medication adherence? In what way?
    - Do you record medication adherence, or record if your advice is heeded? In what way?

7. How do follow ups and referrals happen?
    - Do you just liaise with the patient?
    - Or do you liaise directly with the GP / Practice Nurse?

5: Covid-19-

1. Has Covid-19 had an impact on the way you perform your job?
    - What are those impacts?

2. Has there been an impact on the advice you give to patients?
    - E.g., have you changed the type of advice you give?

3 Has Covid-19 had an impact on your relationships with your patients?
    - What are those impacts?

4. Has Covid-19 had an impact on the type of supports you are providing to patients?
    - What are those impacts?

5. Do you think being able to self-monitor and self-manage their conditions during COVID has impacted the SMILE participants? In what way?
    - Do you think having access to nursing supports during COVID has impacted participants? In what way?

Finishing up-

1. Is it ok to contact you again if I have any further follow up questions?

Appendix E: HCP interview protocol

1: General introduction questions-

1. Can you tell me about the challenges in providing care to your patients with multimorbidity?

2. What is your experience of using technology in your practice?

2: SMILE-

1. Can you tell me why you referred your patient(s) to take part in the SMILE project?

2. Do you think that their participation has been beneficial for your patient(s)?
    - If so, in what way?

3. Have there been any benefits to you from having your patient(s) involved in SMILE?
    - If so, what are they?

4. Has their involvement resulted in any challenges for you?
    - If so, what are they?

5. Did you notice any change in the number of times your patient(s) visited you since they started participating in SMILE, e.g., did they visit more often or did they visit less often?

6. Do you think that these visits were more appropriate?

7. Did being involved in SMILE have an impact on your patient(s) visits?
    - Did you have access to their data? / Did they bring their data with them?
8. Did you have any contact with Caredoc nurses during SMILE?
    - Was this in relation to patient care?
    - If so, would this have been on more than one occasion?

9. How would you see digital technology or the SMILE service being introduced into clinical practice in the future?
    - What are the potential facilitators or barriers?

10. Do you think that giving patient(s) access to this type of technology will help your role in the future?

11. Do you have any concerns about using this type of technology?

12. What surprised you most about the SMILE project?

3: Triage service-

1. What is your opinion of the role of the triage service in supporting your work to help your patients with multimorbidity / chronic diseases to self-manage?

2. What is your opinion of how the triage service may help your role in future?

4: Covid-19-

1. Has Covid-19 had an impact on the way you perform your job?
    - What are those impacts?

2. How has the pandemic impacted your patients with multimorbidity?

3. Has the way that you provide care to your patients changed?
    - If yes, in what way?

4. Do you think having access to digital technology during the pandemic has impacted your patients in any way?

5. Do you think having access to the triage service during this time has impacted the patients in any way?

Finishing up-

1. Would it be ok if I contacted you again if I had any follow up questions?

Appendix F: Thematic analysis coding examples for SMILE interviews

This appendix outlines a number of examples to demonstrate the coding process applied to transcripts from interviews from Study 1, the results of which were presented in Chapter 5. Within each example a number of quotes from transcripts are provided which outline how the quotes (in blue) were initially coded (bolded, in italics and in green) and then clustered, followed by categorisation into sub-themes and themes.

Example No. 1

Quotes from SMP04: Well, I had a lot of challenges, because for four years, sorry, I was diagnosed in 2015 with emphysema and I had a lot of, a lot of infection, a lot of challenge, over the years, those few years up to now with infection (***dealing with infections***).

And at one stage within 14 months I had 24 10-day cases of steroids and antibiotics in 14 months to try and shift, I just couldn't get rid of the infection (***unable to shift infections***).

The challenges really were related with trying to figure out what I could do or what I needed to do to prevent picking up infection (***trying to prevent getting infections***).

Quotes from SMP10: Not really because I can always go to the pharmacy, whatever you need for medication (***COVID has not had a big impact on the PwM because they can get their medication from the pharmacy***).

And it would be an impact just to the extent that where I would maybe in the past have gone down there for like as I said, I had pain in my arm or something, now I wouldn't, I try and just manage it myself (***PwM is self-managing symptoms instead of visiting their GP since COVID***).

Quotes from the GP: So, and sometimes, PwMs get decreased range of functions and sometimes it's very difficult for them you know, to attend a lot of clinics (***PwMs have difficulty getting to clinics because of decreased mobility***).

Sometimes they may be independent or they may be dependent on other people to bring them to clinics (***PwMs are dependent on other people to get to appointments***) so they're a group that we want to try if at all to manage in the community and I think certainly if they've sufficient support they can be managed within the community and in general practice.

Table 1: *Examples of clusters of relevant meaning*

Cluster of Relevant Meaning	Category/Code
SMP04: Well, I had a lot of challenges, because for four years, sorry, I was diagnosed in 2015 with emphysema and I had a lot of, a lot of infection, a lot of challenge, over the years, those few years up to now with infection	Dealing with infections
And at one stage within 14 months I had 24 10-day cases of steroids and antibiotics in 14 months to try and shift, I just couldn't get rid of the infection	Unable to shift infections
The challenges really were related with trying to figure out what I could do or what I needed to do to prevent picking up infection	Trying to prevent infections
GP: So, and sometimes, PwMs get decreased range of functions and sometimes it's very difficult for them you know, to attend a lot of clinics	PwMs have difficulty getting to clinics because of decreased mobility
Sometimes they may be independent or they may be dependent on other people to bring them to clinics	PwMs are dependent on other people to get to appointments
SMP10: Not really because I can always go to the pharmacy, whatever you need for medication	COVID has not had a big impact on the PwM because they can get their medication from the pharmacy
And it would be an impact just to the extent that where I would maybe in the past have gone down there for like as I said, I had pain in my arm or something, now I wouldn't, I try and just manage it myself	PwM is self-managing symptoms instead of visiting their GP since COVID

Table 2: *Examples of themes developing from categorised clusters of data*

Category/Code	Sub-theme	Theme
Dealing with infections Unable to shift infections Trying to prevent infections	Challenges in the self-management of conditions	The challenges and impact of multimorbidity
PwMs have difficulty getting to clinics because of decreased mobility PwMs are dependent on other people to get to appointments	HCPs' perspectives on the challenges PwMs face in self-managing their health	The challenges and impact of multimorbidity
COVID has not had a big impact on the PwM because they can get their medication from the pharmacy PwM is self-managing symptoms instead of visiting their GP since COVID	The impact of COVID-19 on self-management	The challenges and impact of multimorbidity

Example No. 2

Quotes from SMP01: Because I know if I'm doing something right I can see it. And I know if I continue like, if I continue what I'm doing the way I'm doing it, I'm going to stay a lot more healthy (***seeing the impact of good health behaviours on health and well-being***).

Well, like when they're going to the bother of ringing me and keeping an eye out, well I have to play my part as well and do my exercises, get fresh air and you know, just basically what sort of, kind of life I'm living (***the PwM feels a sense of responsibility to the TTNs to self-manage their conditions***).

Quote from SMP02: Well I'd be more intending to keep doing it and keep you know I mean and say "well I have to do my checking on my blood pressure" and all those things, you know ***(the PwM intends to keep taking their readings***).

Quote from SMP04: I would get into a routine, I would do my old readings in the morning, I would do my old readings at night you know, mostly, well whatever before I go to bed at night (***the PwM established a self-management routine***).

Quote from SMP05: The technology, like, I have an iPad and the blood pressure yoke and all there and I take it in the morning when I come back from the walk ***(the PwMs' self-management routine***).

Quote from SMP07: Like when you have a kind of monitor there showing you and telling you like, you do try that little bit harder (***seeing the readings is a motivator***).

Quotes from SMP10: At one stage, they [Caredoc] weren't sure whether they would leave us with the computer and the watch and things. Now they said they would when the project is finished and I will definitely carry it on (***carrying on self-management of conditions after SMILE***).

I figured when I first started that I'd get sick of it and not continue, and I could easily have done that (**the *PwM could have stopped taking the readings***).

That's another reason you carry on because you sort of don't want to let them down (***the PwM does not want to let the TTNs down***).

Table 3: *Examples of clusters of relevant meaning*

Cluster of Relevant Meaning	Category/Code
SMP04: I would get into a routine, I would do my old readings in the morning, I would do my old readings at night you know, mostly, well whatever before I go to bed at night **SMP05:** The technology, like, I have an iPad and the blood pressure yoke and all there and I take it in the morning when I come back from the walk	PwM established a self-management routine PwMs' self-management routine
SMP02: Well I'd be more intending to keep doing it and keep you know I mean and say "well I have to do my checking on my blood pressure" and all those things, you know **SMP10:** At one stage, they [Caredoc] weren't sure whether they would leave us with the computer and the watch and things. Now they said they would when the project is finished and I will definitely carry it on I figured when I first started that I'd get sick of it and not continue, and I could easily have done that	PwM intends to keep taking their readings Carrying on self-management of conditions after SMILE PwM could have stopped taking the readings
SMP01: Well, like when they're going to the bother of ringing me and keeping an eye out, well I have to play my part as well and do my exercises, get fresh air and you know, just basically what sort of, kind of life I'm living **SMP10:** That's another reason you carry on because you sort of don't want to let them down	PwM feels a sense of responsibility to the TTNs to self-manage their conditions PwM does not want to let the TTNs down
SMP01: Because I know if I'm doing something right I can see it. And I know if I continue like, if I continue what I'm doing the way I'm doing it, I'm going to stay a lot more healthy	Seeing the impact of good health behaviours on health and well-being

SMP07: Like when you have a kind of monitor there showing you and telling you like, you do try that little bit harder	Seeing the readings is a motivator

Table 4: *Examples of themes developing from categorised clusters of data*

Category/Code	Sub-theme	Theme
PwM established a self-management routine PwMs' self-management routine	Routines involved in self-management	Engagement in self-management of conditions
PwM intends to keep taking their readings Carrying on self-management of conditions after SMILE PwM could have stopped taking the readings Seeing the impact of good health behaviours on health and well-being Seeing the readings is a motivator	Motivation to engage in and sustain self-management	Engagement in self-management of conditions
PwM feels a sense of responsibility to the TTNs to self-manage their conditions PwM does not want to let the TTNs down	The role of the TTNs in supporting self-management	Engagement in self-management of conditions

Example No. 3:

Quotes from SMP01: Well, I feel as if I knew them but I couldn't put a face on them, you know that kind of way (***the PwM felt they knew the TTNs even though they had never met***).

And they were really encouraging and absolutely brilliant (***the TTNs gave the PwMs encouragement***).

Quote from SMP07: It's probably the friendliness that they provide and, you know, and just give you advice. If your blood pressure is high, they give you advice on it or if your heart rate is gone up for some reason. They just give you little bits of advice, tell you what to do and go and see your GP or whatever if you don't feel well (***getting advice from the TTNs is important to the PwM***).

Quotes from SMP08: It's lovely to think that you can actually talk to somebody, you know, if you have doubts about something, you know (***the PwM felt they could speak to the TTNs about any health worries they had***).
Well, knowing that I can contact them at any time and they can contact me if there's any problems whatsoever. Knowing that they're there at the end of the phone, you know, I think is very important (***it's important for the PwM that they can easily contact the TTNs about any issues they have***).

Quotes from SMP09: It was like having a friend at the end of the phone (***the PwM felt the TTNs were like friends***).

Yes, and I have to say, they were always, you know, very respectful, but very helpful (***the TTNs showed the PwMs respect***).

Quote from TTN01: I mean we've built up some extraordinary relationships with these people. We haven't even met them, it's phenomenal really (***the TTNs and PwMs have extraordinary relationships***).

Table No. 5: *Examples of clusters of relevant meaning*

Cluster of Relevant Meaning	Category/Code
SMP01: Well I feel as if I knew them but I couldn't put a face on them, you know that kind of way And they were really encouraging and absolutely brilliant **SMP08:** It's lovely to think that you can actually talk to somebody, you know, if you have doubts about something, you know **SMP09:** Yes, and I have to say, they were always, you know, very respectful, but very helpful	The PwM felt they knew the TTNs even though they had never met The TTNs gave the PwMs encouragement The PwM felt they could speak to the TTNs about any health worries they had The TTNs showed the PwMs respect
SMP09: It was like having a friend at the end of the phone **TTN01:** I mean we've built up some extraordinary relationships with these people. We haven't even met them, it's phenomenal really	The PwM felt the TTNs were like friends The TTNs and PwMs have extraordinary relationships
SMP07: It's probably the friendliness that they provide and, you know, and just give you advice. If your blood pressure is high, they give you advice on it or if your heart rate is gone up for some reason. They just give you little bits of advice, tell you what to do and go and see your GP or whatever if you don't feel well **SMP08:** Well, knowing that I can contact them at any time and they can contact me if there's any problems whatsoever. Knowing that they're there at the end of the phone, you know, I think is very important	Getting advice from the TTNs is important to the PwM It's important for the PwM that they can easily contact the TTNs about any issues they have

Table No. 6: *Examples of themes developing from categorised clusters of data*

Category/Code	Sub-theme	Theme
PwM felt they knew the TTNs even though they had never met The TTNs gave the PwMs encouragement PwM felt they could speak to the TTNs about any health worries they had The TTNs showed the PwMs respect	The nature of the relationship	The relationship between the PwMs and TTNs
PwM felt the TTNs were like friends The TTNs and PwMs have extraordinary relationships	The quality of the relationship	The relationship between the PwMs and TTNs
Getting advice from the TTNs is important to the PwM It's important for the PwM that they can easily contact the TTNs about any issues they have	The important aspects of the relationship	The relationship between the PwMs and TTNs

Appendix G: ProACT Plus TTN Support participant information leaflet

Study title: The role of nurse-led telephone triage in supporting people with multimorbidity to engage in digital self-management

Researcher Name: Patricia McAleer

You are being invited to take part in a research study to be carried out by Dundalk Institute of Technology (in partnership with Trinity College Dublin and Caredoc).

Before you decide whether or not you wish to take part, you should read the information provided below carefully. It is important that you do not feel rushed or under pressure to decide whether to take part. If you have any questions, you can contact me at patricia.mcaleer@dkit.ie.

You should clearly understand what's involved in taking part in this study so that you can make the decision that is right for you. This process is known as 'Informed Consent'.

You can change your mind about taking part in the study at any time. Even if the study has started, you can still withdraw from it. You don't have to give us a reason. If you do opt out, rest assured that there will be no negative consequences for you.

Why is this study being done?

This study is taking place to find out the role played by a triage service in supporting people with multiple chronic conditions to remain engaged with the digital technology used to self-manage their symptoms and well-being. This study is part of a larger study, namely the SEURO trial being carried out by Dundalk Institute of Technology, in partnership with Trinity College Dublin and Caredoc. As part of the SEURO trial, you are involved in using the ProACT system to self-manage your conditions at home and you are being supported by triage nurses in Caredoc. This particular sub-study is being carried out to understand the role played by triage in supporting your engagement with the digital technology that you use in your self-management.

Who is organising and funding this study?

This SEURO study has received funding under the EU Horizon 2020 Fund.

Why am I being asked to take part?

You are being asked to participate in this portion of the study, as you are participating in the SEURO trial and use the ProACT system. You will have been involved in the SEURO trial and using the ProACT system for a number of months at this point and therefore we are interested in your engagement with using the technology, as well as your engagement with the triage nurses.

How will the study be carried out?

We will ask you to participate in a telephone interview. For this study, we are interested in finding out your opinions on how the triage nurse service has helped you to remain engaged in self-monitoring your health conditions during your time on the SEURO trial.

What will happen to me if I agree to take part?

If you agree to take part, you will be a participant in the study as described in the previous section. The researcher will contact you to determine a time that suits to take part in a telephone interview. This will take up no more than one hour of your time.

Participation in this study is completely voluntary – you can withdraw at any time and you are free to decline to answer some or all of the questions asked to you. You are also entitled to withdraw your data from this study if you wish. You can request your information to be withdrawn from the study at any time, up until the point where it has been completely anonymised and is no longer able to be linked to you, or it has been included anonymously in a publication of research results. Withdrawing from this study will not affect your participation in the SEURO trial.

What are the benefits?

There are no particular benefits to your participation. Your participation in the study will inform our research and help us to better understand and improve the way technology such as ProACT can be used in practice. This will be of benefit to others in the future who might use such technologies.

What are the risks?

There are no risks anticipated with this study.

What if something goes wrong when I'm taking part in this study?

We don't expect that anything will go wrong during the study. You will just be requested to take part in a focus group or interview for approximately one hour.

Is the study confidential?

Your identity will remain confidential at all times. The information that we collect from you during this study will be stored securely.
You will be assigned a unique study ID code, and the information that you provide during the study will be stored under this ID code, separately from your name or other identifying information. Only the researchers listed at the end of this leaflet will be able to link your name with this ID code and your data.

We will use results from the study in research reports, a PhD thesis and publications but we will never use your name or other identifying information in these. We are happy to share the findings of the study with you, once the study has ended and the information collected has been analysed.

We will not keep the information collected during the study for more than 5 years. After this time, we will ensure all information is destroyed. This is in line with Data Protection Legislation.

Where can I get further information?

If you need any further information now or at any time in the future, please contact:

Name: Patricia McAleer

Address: NetwellCASALA Research Centre on Ageing, PJ Carroll's Building, Dundalk Institute of Technology, Dublin Rd.

Appendix H: ProACT No TTN Support participant information leaflet

Study title: The role of nurse-led telephone triage in supporting people with multimorbidity to engage in digital self-management

Researcher Name: Patricia McAleer

You are being invited to take part in a research study to be carried out by Dundalk Institute of Technology (in partnership with Trinity College Dublin and Caredoc).

Before you decide whether or not you wish to take part, you should read the information provided below carefully. It is important that you do not feel rushed or under pressure to decide whether to take part. If you have any questions, you can contact me at patricia.mcaleer@dkit.ie.

You should clearly understand what's involved in taking part in this study so that you can make the decision that is right for you. This process is known as 'Informed Consent'.

You can change your mind about taking part in the study at any time. Even if the study has started, you can still withdraw from it. You don't have to give us a reason. If you do opt out, rest assured that there will be no negative consequences for you.

Why is this study being done?

This study is taking place to find out the role played by a triage service in supporting people with multiple chronic conditions to remain engaged with the digital technology used to self-manage their symptoms and well-being. This study is part of a larger study, namely the SEURO trial being carried out by Dundalk Institute of Technology, in partnership with Trinity College Dublin and Caredoc. As part of the SEURO trial, you are involved in using the ProACT system to self-manage your conditions at home, without support from the triage nurses. Although this study is examining the role of a triage service in digital technology engagement, we also require data from participants who do not have such support, so that we can compare the levels of engagement between those participants who have support and those who do not.

Who is organising and funding this study?

This SEURO study has received funding under the EU Horizon 2020 Fund.

Why am I being asked to take part?

You are being asked to participate in this portion of the study, as you are participating in the SEURO trial and use the ProACT system. You will have been involved in the SEURO trial and using the ProACT system for a number of months at this point and therefore we are interested in your engagement with using the technology, without the support of the triage nurses.

How will the study be carried out?

We will ask you to participate in a telephone interview and short questionnaire also conducted by phone.

What will happen to me if I agree to take part?

If you agree to take part, you will be a participant in the study as described in the previous section. The researcher will contact you to determine a time that suits to take part in a telephone interview. This will take up no more than one hour of your time.

Participation in this study is completely voluntary – you can withdraw at any time and you are free to decline to answer some or all of the questions asked to you. You are also entitled to withdraw your data from this study if you wish. You can request your information to be withdrawn from the study at any time, up until the point where it has been completely anonymised and is no longer able to be linked to you, or it has been included anonymously in a publication of research results. Withdrawing from this study will not affect your participation in the SEURO trial.

What are the benefits?

There are no particular benefits to your participation. Your participation in the study will inform our research and help us to better understand and improve the way technology such as ProACT can be used in practice. This will be of benefit to others in the future who might use such technologies.

What are the risks?

There are no risks anticipated with this study.

What if something goes wrong when I’m taking part in this study?

We don’t expect that anything will go wrong during the study. You will just be requested to take part in a focus group or interview for approximately one hour.

Is the study confidential?

Your identity will remain confidential at all times. The information that we collect from you during this study will be stored securely.

You will be assigned a unique study ID code, and the information that you provide during the study will be stored under this ID code, separately from your name or other identifying information. Only the researchers listed at the end of this leaflet will be able to link your name with this ID code and your data.

We will use results from the study in research reports, a PhD thesis and publications but we will never use your name or other identifying information in these. We are happy to share the findings of the study with you, once the study has ended and the information collected has been analysed.

We will not keep the information collected during the study for more than 5 years. After this time, we will ensure all information is destroyed. This is in line with Data Protection Legislation.

Where can I get further information?

If you need any further information now or at any time in the future, please contact:

Name: Patricia McAleer

Address: NetwellCASALA Research Centre on Ageing, PJ Carroll's Building, Dundalk Institute of Technology, Dublin Rd.

Appendix I: Participant ProACT Plus TTN Support interview protocol

Introduction questions:

1. Can you tell me why you got involved in the SEURO project?

2. Can you tell me about how you managed your conditions before taking part?
    - Have you received any help from your GP, Practice Nurse, clinic nurses or family member to self-manage your conditions before the trial?

3. Did you use technology for self-managing your conditions before the project?
    - If so, what type of devices did you use?
    - Did you get any support from family, friends, GP, Practice Nurse or clinic nurses to use the technology?

4. Did you have any issues or challenges to deal with in managing your conditions before the trial?

General questions:

1. I want to ask you some questions about how you use the ProACT CareApp, the devices and the iPad. First of all, can you tell me what are you monitoring?
    - How often do you take those readings?
    - How often do you view the readings?
    - How often do you set a walking goal?
    - How often do you use the medication management feature?
    - How often do you answer the daily questions?
    - How often do you look at the educational content?
    - **Prompt (for each question above):**
        - **Can you tell me why that is?**
    - Since the start of the trial, has your level of engagement changed in anyway?
        - **Prompt – Has the number of times you use the technology per day or week changed since you started using it?**
        - **Why is that?**

2. Now I'm going to ask you a bit more about how you use your readings data. Thinking about all of the things you are managing, such as blood pressure, weight, activity etc.
    - What have been the benefits of having access to this information?
    - What have been the challenges of having access to this information?
    - Can you tell me if there is any time when you haven't understood the readings and how you dealt with that?
        - Do you feel now that you understand them? Why is that?
        - What do you do if you get a reading that you think is too high / low?
    - Have you had any support in understanding / taking action on your readings?
        - **Prompt: from family / friend, triage, GP or other health care professional**

3. How, if at all, has being involved helped you to manage your conditions better than you were managing them before the trial?
4. What has motivated you to continue engaging with the technology to self-manage?
    - **Prompts:**
    - **Health benefits / support / contributing to research**

5. Have you discussed your readings with your GP, Practice Nurse or clinical nurses?
    - If so, can you tell me how that went?
    - If not, can you tell me why that is?

6. Can you give me three good things about participating in the trial?

7. Can you give me three bad things about it?

8. Is there anything else you'd like to add?

9. **Extra question if participant isn't tired:** Can you tell me what issues or challenges you have (if you have any) with using the technology? For instance:
    - Do you have any issues or challenges with using the CareApp?
        - If so, how have you overcome those issues or challenges?
    - Do you have any issues or challenges with using any of the devices?
        - If so, can you tell me which ones?
        - Can you tell me how you have overcome those issues or challenges?
    - Do you have any issues or challenges with using the iPad?
        - If so, how have you overcome those issues or challenges?

Triage Nurses questions:

1. I'd now like to ask you some questions about the Caredoc nurses. How would you describe your relationship with the nurses?

2. What do you feel is the most important part of your relationship with the Caredoc nurses?

3. In what way, if any, do the Caredoc nurses support you to self-manage your conditions?
    - What do you feel is the most important support that they give you?
    - If you didn't have the nurse support, how to you think you would manage?

4. In what way, if any, do you think that having access to the Caredoc nurses makes a difference to how often you use the CareApp and devices?
    - **Prompt: do you think you would use the technology more often or less often without the nurses?**
    - **Can you tell me why that is?**

5. Do you have any challenges in dealing with the Caredoc nurses?
    - If so, what are the problems or issues?
    - How do you deal with the problems or issues?

6. Has there been any benefit to you in having access to the Caredoc nurses?
    - If yes, what have those benefits been?

7. In what way, if any, does having the support of the Caredoc nurses motivate you to engage with the technology to manage your conditions?
    - If not, can you tell me why you think that is?

8. Can you tell me a bit about what, if any, advice the Caredoc nurses give you that supports your self-management?
    - Do you follow the advice that the Caredoc nurses give you?
        - Can you tell me why that is?
    - Have you regretted taking their advice?
    - Have you regretted not taking their advice?

9. How important is it to you to have any questions that you may have about your conditions answered by the Caredoc nurses?
    - Why is / isn’t this important?

10. Is there anything else that you’d like to add?

Thank you for your time today. If there’s anything else I need to come back to you with, is it alright if I contact you again?

Appendix J: Participant ProACT No TTN Support interview protocol

Introduction questions:

1. Can you tell me why you got involved in the SEURO project?

2. Can you tell me about how you managed your conditions before taking part?
    - Have you received any help from family, friends, GP, Practice Nurse or clinic nurses to self-manage your conditions before the trial?

3. Did you use technology for self-managing your conditions before the project?
    - If so, what type of devices did you use?
    - Did you get any support from family, friends, GP, Practice Nurse or clinic nurses to use the technology?

4. Did you have any issues or challenges to deal with in managing your conditions before the trial?

General questions:

1. I want to ask you some questions about how you use the ProACT CareApp, the devices and the iPad. First of all, can you tell me what are you monitoring?
    - How often do you take those readings?
    - How often do you view the readings?
    - How often do you set a walking goal?
    - How often do you use the medication management feature?
    - How often do you answer the daily questions?
    - How often do you look at the educational content?
    - **Prompt (for each question above):**
        - **Can you tell me why that is?**
    - Since the start of the trial, has your level of engagement changed in anyway?
        - **Prompt – Has the number of times you use the technology per day or week changed since you started using it?**
        - **Why is that?**

2. Now I'm going to ask you a bit more about how you use your readings data. Thinking about all of the things you are managing, such as blood pressure, weight, activity etc.
    - What have been the benefits of having access to this information?
    - What have been the challenges of having access to this information?
    - Can you tell me if there is any time when you haven't understood the readings and how you dealt with that?
        - Do you feel now that you understand them? Why is that?
        - What do you do if you get a reading that you think is too high / low?
    - Have you had any support in understanding / taking action on your readings?
        - **Prompt: from family / friend, triage, GP or other health care professional**

3. How, if at all, has being involved helped you to manage your conditions better than you were managing them before the trial?
4. What has motivated you to continue engaging with the technology to self-manage?
    - **Prompts:**
    - **Health benefits / support / contributing to research**

5. Have you discussed your readings with your GP, Practice Nurse or clinical nurses?
    - If so, can you tell me how that went?
    - If not, can you tell me why that is?

6. Can you give me three good things about participating in the trial?

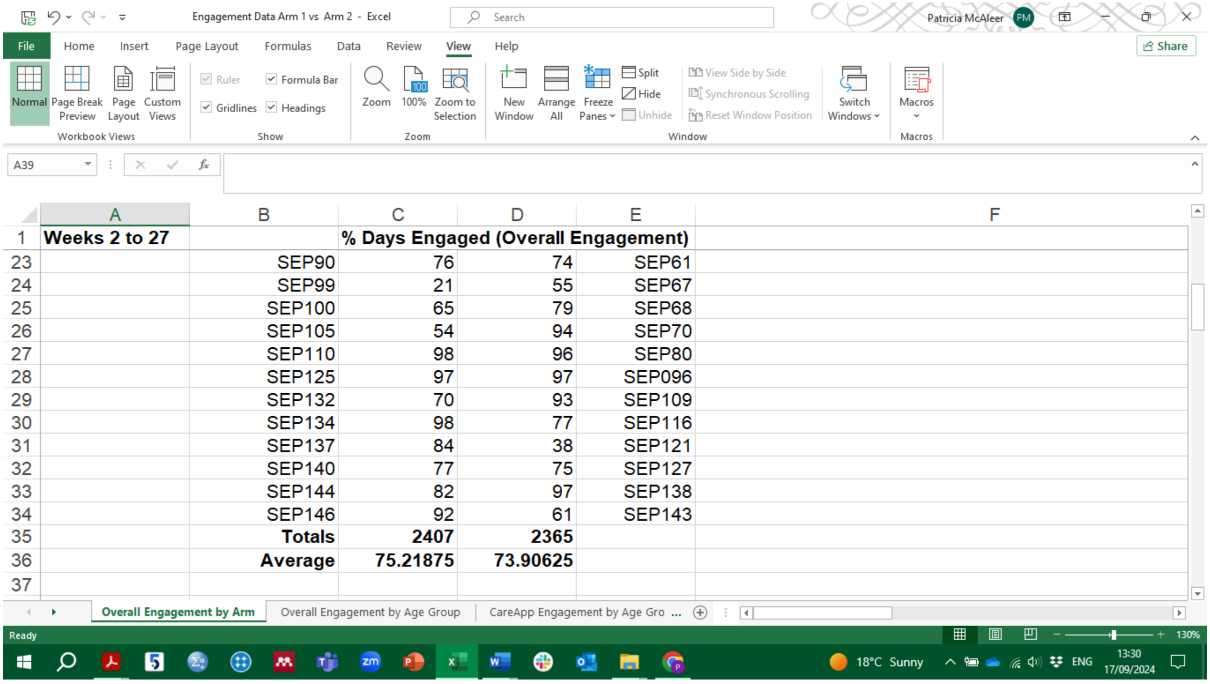
7. Can you give me three bad things about it?

8. Is there anything else you'd like to add?

9. **Extra question if participant isn't tired**: Can you tell me what issues or challenges you have (if you have any) with using the technology? For instance:
    - Do you have any issues or challenges with using the CareApp?
        - If so, how have you overcome those issues or challenges?
    - Do you have any issues or challenges with using any of the devices?
        - If so, can you tell me which ones?
        - Can you tell me how you have overcome those issues or challenges?
    - Do you have any issues or challenges with using the iPad?
        - If so, how have you overcome those issues or challenges?

Thank you for your time today. If there's anything else I need to come back to you with, is it alright if I contact you again?

Appendix K: Example of engagement data calculations



	A	B	C	D	E	F
1	**Weeks 2 to 27**		**% Days Engaged (Overall Engagement)**			
23		SEP90	76	74	SEP61	
24		SEP99	21	55	SEP67	
25		SEP100	65	79	SEP68	
26		SEP105	54	94	SEP70	
27		SEP110	98	96	SEP80	
28		SEP125	97	97	SEP096	
29		SEP132	70	93	SEP109	
30		SEP134	98	77	SEP116	
31		SEP137	84	38	SEP121	
32		SEP140	77	75	SEP127	
33		SEP144	82	97	SEP138	
34		SEP146	92	61	SEP143	
35		**Totals**	**2407**	**2365**		
36		**Average**	**75.21875**	**73.90625**		
37						

Appendix L: Study 1 ethics approval letter

23rd January 2020

Ms. Patricia McAleer,
NetwellCASALA Research Centre,
School of Health and Science,
Dundalk Institute of Technology,
Dundalk,
Co. Louth.

Re: The role of nurse-led telephone triage in supporting people with multimorbidity to digitally self-manage

Dear Patricia,

The School Ethics Committee reviewed the ethics application for the above study at its meeting dated the 16th December 2019. I note the amendments which you sent to me on the 23rd January 2020. This application is now approved.

Wishing you the best of luck in your research.

Yours Sincerely,

Edel Healy

Dr Edel Healy
Chair of School of Health & Science Ethics Committee

cc. Dr Julie Doyle; Ms. Suzanne Smith

Appendix M: Study 2 ethics approval letter

11th January 2023

Ms. Patricia McAleer,
NetwellCASALA Research Centre,
School of Health and Science,
Dundalk Institute of Technology,
Dundalk,
Co. Louth.

Re: The role of nurse-led telephone triage in supporting people with multimorbidity to engage in digital self-management

Dear Patricia,

The above study was originally approved on the 8th November 2021. The amended study was reviewed at the School Ethics Committee at its meeting dated 13th December 2022. I acknowledge the further amendments which you sent to me dated the 5th January 2023. These were also reviewed by the Committee. This application is now approved.

Wishing you the best of luck in your research.

Yours Sincerely,

Edel Healy

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Dr Edel Healy
Chair of School of Health & Science Ethics Committee

cc. Dr Julie Doyle

Appendix N: Key findings of this PhD

Key Findings	
Chapter Five Findings	**The Impact of Multimorbidity** **1.** Despite the heavy burden of multimorbidity on the SMILE PwMs such as a lack of awareness of their conditions, pain, prolonged infections and frequent visits to various HCPs, the PwMs appeared to cope well with their illnesses, with only one PwM speaking about multimorbidity's mental impacts.
	Self-management of Conditions **1.** The PwMs perceived that COVID-19 had not impacted the self-management of their conditions, because even when they were unable to visit their GPs, they were content to take advice from the TTNs instead. **2.** From the TTNs' perspective, they felt that the PwMs experienced loneliness and depression as a result of not being able to see their families during the lockdowns. As a result, they were giving the PwMs more emotional support than they had been doing before COVID-19.
	Motivation to Self-manage **1.** Seeing their readings motivated self-management because the PwMs could see the positive impacts it was having on their health. **2.** Eight of the PwMs were motivated to take their readings because they knew the TTNs were monitoring them, which for them was a positive thing.
	Barriers to Self-management During the SMILE Trial **1.** The main barriers were problems with the DHT such as issues with the iPad, blood pressure monitor and the smart watch. **2.** The PwMs continued using ProACT despite experiencing difficulties with it because they could see the health benefits they got from using it, and they felt well supported by the trial technical support staff to sort the issues out'.
	Engagement with ProACT **1.** The PwMs felt they should take responsibility for their own health so they were prepared to engage with the DHT. **2.** They also felt a sense of responsibility to the TTNs which meant that they continued engaging with the DHT to self-manage their conditions.

<table>
<tr><th colspan="2">Key Findings</th></tr>
<tr><td rowspan="3">Chapter Five Findings (ctd.)</td><td>The Work of the TTNs
1. Strategies the TTNs used with the PwMs to ensure that their advice was followed included using humour, encouragement and not ‘telling the PwMs off’.

2. The TTNs took time to talk to the PwMs about issues other than their health helping them to create an holistic relationship, which enabled the PwMs to get more out of the triage service.
3. The PwMs appreciated that the TTNs for helping them to get technical assistance with the DHT.</td></tr>
<tr><td>The TTNs’ Support for the PwMs
1. The TTNs’ advice was always followed by the PwMs because they felt they were getting good advice from professionals who had the expertise to advise them correctly.

2. The advice from the TTNs was very important to the PwMs as was the consistency of the contact between them, because it helped to allay any health concerns they had.

3. Peace of mind was an important outcome for the PwMs which was as a result of being monitored by the TTNs. They knew that if a reading was outside their normal range, the TTNs would contact them about it.</td></tr>
<tr><td>The Relationship Between the PwMs and the TTNs
1. The bond between the PwMs and the TTNs was close, even though it was a remote relationship.

2. PwMs spoke about how friendly the TTNs were and how they felt they could speak about anything to them. They felt that the TTNs took time to talk to them, something they did not experience with their own GPs.

3. The TTNs built a rapport with the PwMs by being friendly. Knowing the PwMs on a deeper level meant that the TTNs were able to ‘pick up on cues’ when speaking to them, so they were able to provide the PwMs with appropriate care. This was important as they were not dealing with them face-to-face.</td></tr>
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Key Findings	
Chapter Five Findings (ctd.)	**The Benefits and Outcomes of SMILE** **1.** Health improvements such as stabilisation of conditions and fewer infections were reported. **2.** Improvements in health behaviours such as healthier eating and taking exercise were also reported. **3.** All 10 PwMs mentioned having 'peace of mind' because of the monitoring from the TTNs.
Chapter Six Findings	**PwMs' Overall Engagement with ProACT** 1. ***Any engagement by trial cohort***: **a.** ProACT Plus TTN Support engaged slightly more on average than ProACT No TTN Support (75.22% vs 73.91% days engaged). **2.** ***Any engagement by trial cohort and age group***: **a. 65-74 years age group:** ProACT Plus TTN Support engaged less than ProACT No TTN Support (63.27% vs 72.23% days engaged). **b. 75-84 years age group:** ProACT Plus TTN Support engaged slightly more than ProACT No TTN Support (85.31% vs 83.71% days engaged). **c. 85+ years age group:** ProACT Plus TTN Support engaged significantly more than ProACT No TTN Support (87.25% vs 52.33% days engaged).
	Engagement with Health Monitoring Devices **1.** ***The number of vitals measures taken by trial cohort***: **a.** Of the total number of 14,106 measures taken, overall, ProACT Plus TTN Support took more measures than ProACT No TTN Support (7,545 vs 6,561). **b.** ProACT Plus TTN Support took more measures than ProACT No TTN Support with all of the devices except the blood glucometer (763 vs 1,069 measures) (n=12 ProACT Plus TTN Support, n=21, ProACT No TTN Support). **c.** ProACT Plus TTN Support took a higher average number of measures per week from week 2 to week 27 than ProACT No TTN Support (290.19 vs 252.35), with the total average number of measures taken per week being 542.54. **2**. ***The number of vitals measures taken by trial cohort and age group***: **a.** The highest total number of measures was taken by ProACT No TTN Support's 65-74 age group PwMs (4,456), while the lowest total number taken was 418 by ProACT No TTN Support's 85+ years age group. **b.** By device, ProACT No TTN Support's 65-74 years age group also took the highest number of measures which were with the weighing scales (1,517 measures). **c.** The lowest number of measures by device was taken by ProACT No TTN Support's 85+ years age group with both the blood glucose monitor and the pulse oximeter.

Key Findings

Chapter Six Findings (ctd.)

Engagement with the CareApp and its Features

1. *The CareApp by trial cohort*:

a. Overall CareApp engagement (opening the CareApp) was slightly higher in ProACT Plus TTN Support than ProACT No TTN Support (engagement on 54.16% of days vs 46.10% of days).

b. Engagement with the vitals section of the CareApp occurred on 47.84% of days for ProACT Plus TTN Support and 43.63% of days for ProACT No TTN Support.

c. ProACT Plus TTN Support engaged with the activity, self-report, education and medication sections of the CareApp on a higher percentage of days than ProACT No TTN Support.

d. ProACT Plus TTN Support PwMs completed significantly more self-survey reports than ProACT No TTN Support PwMs (2,636 vs 1,403), they also on average completed significantly more surveys (82.38 vs 43.84) as well as the largest average number of surveys completed each week (3.06 vs 1.72).

2. *Activity goal setting by trial cohort*:

a. More PwMs in ProACT Plus TTN Support set an activity goal than in ProACT No TTN Support (13 vs 11).

b. PwMs in ProACT Plus TTN Support set more activity goals than in ProACT No TTN Support (22 vs 2).

c. ProACT Plus TTN Support set a slightly higher average number of goals per week than ProACT No TTN Support (21.69 vs 21).

d. ProACT No TTN Support on average met more activity goals than ProACT Plus TTN Support (9 vs 6.38).

3. *The CareApp by trial cohort and age group*:

a. ProACT Plus TTN Support PwMs in the 75-84 years age group had the highest level of days engagement (71.85%) with the CareApp, whilst the lowest level of days engagement was that of ProACT No TTN Support PwMs in the 85+ age group on 13% of days.

b. ProACT Plus TTN Support's 75-84 years age group PwMs engaged significantly more than their ProACT No TTN Support counterparts (71.85% vs 43.71% days engaged).

c. 65-74 years age group: ProACT Plus TTN Support engaged slightly less with the devices than ProACT No TTN Support (48.60% vs 51.50% days engaged).

d. 75-74 years age group: ProACT Plus TTN Support engaged more than ProACT No TTN Support (71.85 vs 43.71% days engaged).

e. 85+ years age group: ProACT Plus TTN Support engaged slightly more than ProACT No TTN Support (17.50% vs 13% days engaged).

f. Engagement with the vitals section of the CareApp was highest in ProACT Plus TTN Support's 75-84 years age group (70.38% of days engaged).

g. In relation to the activity, self-report, education and medication sections of the CareApp, across both trial cohorts and age groups the highest level of engagement was with the medication feature while the lowest was with the education feature.

h. ProACT Plus TTN Support's 65-74 years age group completed the highest number of self-survey reports (1,306) while ProACT No TTN Support's 75-84 years age group completed the lowest number (106).

	Key Findings
Chapter Six Findings (ctd.)	**4.** ***Activity goal setting by trial cohort and age group*****:** **a.** The age group with the most PwMs to set an activity goal was the 65-74 years age group (17) and this cohort set the highest number of goals (25). They also set goals on an average of 21.89 weeks for ProACT Plus TTN Support and 22.13 for ProACT No TTN Support, but met these goals on an average of 6.22 and 7 weeks respective. **b.** ProACT Plus TTN Support's 75-84 years group PwMs set more goals than ProACT No TTN Support's (19.67 vs 14) but it was ProACT No TTN Support who met more goals (10 vs 7). **c.** Meanwhile, the two 85+ years age group PwMs (one from each cohort) each set goals on an average of 26 weeks which was the highest average number of weeks a goal was set. In addition, the ProACT No TTN Support PwM in this age group met the activity goals on the highest average number of weeks (23).
	TTN Supports **1.** ***TTN supports to ProACT Plus TTN Support PwMs overall*****:** **a.** 430 phone calls in total were made by the TTNs to the 32 ProACT Plus TTN Support PwMs (238 unscheduled/192 scheduled). **b.** 32 PwMs received 37 referrals from the TTNs to other HCPs. 34 were made for the GP, one for emergency care and two other referrals were unspecified, while none were made for specialist care**.** In total the TTNs dealt with 1,625 device alerts, of which 324 were addressed and 1,301 were dismissed. The blood pressure monitor caused the highest number of alerts (1,094), while the pulse oximeter caused the lowest number (58). **2.** ***TTN supports to ProACT Plus TTN Support PwMs by age group*****:** **a.** Of the 430 phone calls made by the TTNs to the 32 PwMs, 215 were made to the 65-74 years age group, 177 to the 75-84 years age group and 45 to the 85+ years age group. **b.** 16 PwMs received referrals to other HCPs; seven PwMs in the 65-74 years age group, seven in the 75-84 years age group and two in the 85+ years age group received referrals to the GP. Further, one PwM in the 75-84 years age group received referrals to the GP and emergency care, while two PwMs in the 75-84 years age group received GP and other referrals. **c.** The majority of device alerts dealt with by the TTNs was for the blood pressure monitor (102 addressed and 460 dismissed). The lowest number of alerts occurred with the weighing scales for the 85+ years age group (17) of which two were addressed and 15 dismissed.

Key Findings	
Chapter Seven, Part 1 Findings	**PwMs' Overall Engagement with ProACT** **1.** ***Any engagement by trial cohort*****:** **a.** On average the PwMs in ProACT Plus TTN Support engaged on 83.92% of days, while those in ProACT No TTN Support engaged on 78.67% of days. **2.** ***Any engagement by trial cohort and age group*****:** **a. 65-74 years age group:** ProACT Plus TTN Support engaged slightly less than ProACT No TTN Support (75.80% vs 78.13% days engaged). **b. 75-84 years age group:** ProACT Plus TTN Support engaged slightly less than ProACT No TTN Support (88% vs 88.33% days engaged). **c. 85+ years age group:** ProACT Plus TTN Support engaged significantly more than ProACT No TTN Support (94% vs 54% days engaged).
	Engagement with Health Monitoring Devices **1.** ***The number of vitals measures taken by trial cohort*****:** **a.** Of the total number of 6,043 measures taken, overall, ProACT Plus TTN Support took more measures than ProACT No TTN Support (3,328 vs 2,715). **b.** ProACT Plus TTN Support took more measures than ProACT No TTN Support with all the devices except the blood glucometer (368 vs 554) (n=5 ProACT Plus TTN Support, n=11 ProACT No TTN Support. **c.** ProACT Plus TTN Support took a higher average number of measures per week from week 2 to week 27 than ProACT No TTN Support (128 vs 104.42), with the total average number of measures taken per week being 232.42. **2.** ***The number of vitals measures taken by trial cohort and age group*****:** **a.** The highest total number of measures was taken by ProACT No TTN Support's 65-74 years age group (1,711), while the lowest total number taken was 134 by ProACT No TTN Support's 85+ age group. **b.** By device, ProACT No TTN Support's 65-74 years age group also took the highest number of measures (566) which were with the weighing scales, while the lowest number of measures taken was by ProACT No TTN Support's 85+ years age group which were taken with the blood pressure monitor (64). **c.** no measures were taken with the blood glucose monitor by the 85+ age group, despite one PwM in this age group in ProACT No TTN Support having diabetes and access to a blood glucometer. **d.** The highest average number of measures taken per week from week 2 to week 27 was 65.81 by ProACT No TTN Support's 65-74 years age group, while the lowest average number taken was 5.15 by ProACT No TTN Support's 85+ years age group.

	Key Findings
Chapter Seven, Part 1 Findings (ctd.)	**3. Engagement with the CareApp and its Features** **1. *The CareApp by trial cohort*:** **a.** Overall CareApp engagement (opening the CareApp) was slightly higher in ProACT Plus TTN Support (61.67% days engaged) than in ProACT No TTN Support (57.08% days engaged). **b.** Engagement with the vitals section of the CareApp occurred on 57.75% days for ProACT Plus TTN Support and 54.67% of days for ProACT No TTN Support. **c.** The most engagement with the activity, self-report and education features came from ProACT Plus TTN Support (29.17% of days, 20.50% of days and 4.50% of days respectively), while ProACT No TTN Support's engagement with the same features was 3.25% of days, 11.75% of days and 2.42% of days respectively. **d.** ProACT Plus TTN Support engaged more than ProACT No TTN Support with the self-report (20.50% vs 11.75% days engaged) and education (4.50% vs 2.42% days engaged) features. **e.** ProACT No TTN Support engaged slightly more with the medication feature than ProACT Plus TTN Support (26.42% vs 24.17% days engaged). **f.** ProACT Plus TTN Support PwMs completed more self-report surveys than ProACT No TTN Support PwMs (1,353 vs 863). **g.** ProACT Plus TTN Support participants also on average completed more surveys (112.75 vs 71.83) and on average, more surveys each week (8.17 vs 4.58). **2. *Activity goal setting by trial cohort*:** **a.** More PwMs in Arm 1 set an activity goal than in Arm 2 (5 vs 4). **b.** PwMs in Arm 1 set a higher number of activity goals than Arm 2 (12 vs 5). **c.** Arm 1 set a higher average number of goals per week than Arm 2 (23 vs 21). **d.** Arm 2 met a higher average number of activity goals per week than Arm 2 (11.50 vs 9.20). **3. *The CareApp by trial cohort and age group*:** **a.** The highest level of engagement with the CareApp came from ProACT Plus TTN Support's 75-84 years age group (83.80% days engaged), while the lowest level came from ProACT Plus TTN Support's 85+ years age group (16.50% days engaged). **b.** The age group with the smallest difference in CareApp engagement between the cohorts was in the 75-84 years age group with ProACT Plus TTN Support being engaged on 83.80% of days and ProACT No TTN Support being engaged on 81.66% of days. **c.** In the 65-74 years age group ProACT Plus TTN Support engaged slightly more with the devices than ProACT No TTN Support (57.60% vs 50.75% days engaged). **d.** In the 85+ age group ProACT No TTN Support engaged more than ProACT Plus TTN Support (34% vs 16.5% days engaged). **e.** ProACT Plus TTN Support's 75-84 years age group recorded the highest usage of the vitals section of the CareApp, visiting this section on 83.80% of days, which was slightly higher than their ProACT No TTN Support counterparts who recorded engagement on 79% of days.

Key Findings	
Chapter Seven, Part 1 Findings (ctd.)	**3.** ***The CareApp by trial cohort and age group (ctd.)*****:** **f.** The lowest level of engagement with the vitals section of the CareApp came from the 85+ years age group, with ProACT Plus TTN Support's participants using it least of all (5.50% of days engagement), followed by ProACT No TTN Support's participants who used it on 31% of days. **g.** Across the three categories and six age groups, ProACT No TTN Support's 75-84 years age group had the highest level of engagement with the medication feature (52.33% days engaged). **h.** The medication feature was the most used feature for the 65-74 years age group in both trial cohorts (ProACT Plus TTN Support=25% and ProACT No TTN Support=19.25% days engaged). **i.** The lowest level of engagement with any feature was with the education feature in ProACT No TTN Support's 65-74 years age group (1.13% days engaged) and it was also the least engaged with feature for ProACT Plus TTN Support's 65-74 years age group (3.60% days engaged) and both cohorts' 75-84 years age groups (ProACT Plus TTN Support=3.80% vs ProACT No TTN Support=4.67% days engaged). **j.** For the 85+ years age group, they engaged least with the self-report feature (5.50% days engaged in ProACT Plus TTN Support and 2% days engaged in ProACT No TTN Support). **k.** ProACT Plus TTN Support's 75-84 years age group completed the highest number of self-report surveys (827), while ProACT Plus TTN Support's 85+ years age group completed the lowest (1). **4.** ***Activity goal setting by trial cohort and age group*****:** **a.** ProACT Plus TTN Support's 65-74 years age group set the highest number of goals (9), while ProACT Plus TTN Support's 85+ years age group set the lowest (1). **b.** The highest average number of weeks a goal was set was 26 by ProACT Plus TTN Support's 85+ years age group and the lowest average number of weeks a goal was set was 20 by the 75-84 years age group in both cohorts. **c.** The highest average number of weeks a goal was met was 20 by ProACT Plus TTN Support's 75-84 years age group and the lowest average number of weeks a goal was met was 2.67 by ProACT No TTN Support's 65-74 years age group.
Chapter Seven, Part 2 Findings	**TTN Supports** ***TTN Supports to ProACT Plus TTN Support PwMs Overall*** **a.** 147 phone calls in total were made by the TTNs to the 12 ProACT Plus TTN Support PwMs (75 scheduled/72 unscheduled). **b.** Seven PwMs receive 18 referrals from the TTNs to other HCPs. 17 of these were for the GP and one was unspecified. **c.** In total the TTNs dealt with 563 device alerts, the majority of which (473) were dismissed and 90 were addressed. The blood pressure monitor caused the largest number of alerts (428), while the pulse oximeter caused the smallest number (27).

Key Findings	
Chapter Seven, Part 2 Findings (ctd.)	***TTN Supports to ProACT Plus TTN Support PwMs by Age Group*** **a.** Of the 147 phone calls made to the 12 ProACT Plus TTN Support PwMs during their 26 weeks on the trial, 83 were made to the 65-74 years group, 40 to the 75-84 years group and 24 to the 85+ years group. **b.** The highest number of calls made to the three age groups was seven which was in week six to the 65-74 years age group. In weeks eight and 12 this age group received no TTN calls, in five weeks (three, nine, 14, 20 and 23) the 75-84 age group received none, and finally, in nine weeks the 85+ age group also received none (weeks four, eight, 10, 12, 13, 16, 17, 19 and 21). **c.** Of the 563 device alerts dealt with by the TTNs, the blood pressure monitors in the 75-84 years age group caused the highest number (196). 27 of these were addressed and 169 dismissed. **d.** The lowest number was for the blood glucose monitor in the 65-74 years age group (three) two of which were addressed and one dismissed.
	Self-management of Conditions using ProACT **1.** The majority of PwMs (ProACT Plus TTN Support=7, ProACT No TTN Support=8) had experience using DHT prior to participating in the SEURO trial, primarily using blood glucose monitors, blood pressure monitors and pulse oximeters. **2.** Five ProACT Plus TTN Support and four ProACT No TTN Support PwMs reported that they had not been taking readings on a regular basis prior to the trial, while two ProACT Plus TTN Support PwMs relied on their GP to do this for them. **3.** The PwMs found the ProACT platform easy to use regardless of their prior experiences of using DHT, with 11 PwMs in each cohort expressing positive opinions of it. **4.** Eight PwMs (ProACT Plus TTN Support=5, ProACT No TTN Support=3) had negative perceptions of some aspects of ProACT, such as for example, two PwMs (one from each cohort) finding that taking their readings was a 'chore' and finding the trial to be 'repetitive' and 'tedious'.
	Barriers to Self-management **1.** The majority of issues with the DHT were technical in nature rather than physical, as reported by eight ProACT Plus TTN Support and seven ProACT No TTN Support PwMs. These included being locked out of the iPad and needing a password re-set, remembering to keep the iPad charged, and devices not syncing with the iPad, for example.

Key Findings	
Chapter Seven, Part 2 Findings (ctd.)	**Engagement with ProACT** **1.** The majority of PwMs took their readings at least once daily (11 PwMs in ProACT Plus TTN Support and 12 PwMs in ProACT No TTN Support). Ten PwMs (five from each cohort) looked at the readings daily, nine PwMs (ProACT Plus TTN Support=3, ProACT No TTN Support=6) looked at them sometimes, while five PwMs (ProACT Plus TTN Support=4, ProACT No TTN Support=1) never looked at them. **2.** Of the five PwMs who did not look at their readings, reasons given were because of the TTN monitoring, symptom stabilisation or a fear of using the iPad in case the PwM broke it. **3.** Using the CareApp's well-being features: **a.** 13 PwMs (ProACT Plus TTN Support=6, ProACT No TTN Support=7) stated that they used the self-report feature. **b.** Seven PwMs (ProACT Plus TTN Support=4, ProACT No TTN Support=3) used the exercise goal setting feature. **c.** Seven PwMs (ProACT Plus TTN Support=4, ProACT No TTN Support=3) also used the medication management feature. **d.** The educational content was accessed by 10 PwMs (ProACT Plus TTN Support=6, ProACT No TTN Support=4). **4.** A lack of awareness of the features was mentioned by the PwMs when asked why they were not using them. In the case of the self-report feature one ProACT Plus TTN Support and three ProACT No TTN Support PwMs gave this reason. Three PwMs (ProACT Plus TTN Support=2, ProACT No TTN Support=1) were unaware of the medication management feature, and finally, three ProACT Plus TTN Support and two ProACT No TTN Support PwMs were unaware of the education feature.
	Changes in Engagement with ProACT **a.** 19 PwMs (ProACT Plus TTN Support=9, ProACT No TTN Support=10) perceived that their level of engagement with the DHT had not changed since commencing the trial. **b.** Three PwMs' engagement levels had changed – one ProACT Plus TTN Support PwM used it less frequently, while two ProACT No TTN Support PwMs used it more frequently. **c.** Five PwMs reported that they would use the technology less often without the TTNs monitoring them, because being monitored is what motivated them to use it. **d.** One PwM stated that she would use it more often because she would not have the reassurance of being monitored. **e.** Six PwMs stated that the TTNs made no difference in their use of ProACT.

Key Findings	
Chapter Seven, Part 2 Findings (ctd.)	**Motivation to use ProACT (ctd.)** **2.** The PwMs learned about their vital signs and could identify spikes in their conditions, taking necessary actions such as consulting their GP, rechecking readings, or making lifestyle adjustments where necessary. **3.** Some PwMs became more proactive with their self-management by seeking medical help, exercising more and managing their conditions. **4.** The PwMs were reassured because of their readings which reduced their uncertainty in managing their conditions. **5.** For some participants, contributing to research was a key motivator, whether to advance scientific knowledge, find medical cures, or to help others. Three PwMs (ProACT Plus TTN Support=1, ProACT No TTN Support=2) who perceived they did not personally benefit from their participation in the study continued to participate out of a sense of commitment. **6.** One ProACT Plus TTN Support PwM stated that monitoring had become a routine part of her day and that she felt positive about contributing to the trial and was motivated to help others.
	The TTNs' Support for the PwMs **1.** The ProACT Plus TTN Support PwMs felt reassured knowing that they were being monitored by the TTNs, with nine of them relating that this was important to them. **2.** Seven PwMs felt that the TTNs were reliable and they knew that they would be contacted by the TTNs in the event of a high reading. **3.** Having their health-related questions answered by the TTNs was not important for four PwMs who felt capable of managing their conditions. For the six PwMs to whom it was important, this was because it would alleviate their anxiety or would save them from having to visit the GP. **4.** When asked about self-managing without the TTNs' support, one PwM perceived that she did not need their support, and the remaining 11 PwMs felt that they would continue managing their health as they always had done, as they felt that they had been self-managing well before the SEURO trial. **5.** Nevertheless, for five PwMs, having the support was important as the TTNs were able to spot exacerbations, provide appropriate advice and prompt the PwMs into taking action when their readings were high.

Key Findings	
Chapter Seven, Part 2 Findings (ctd.)	**The Relationship Between the PwMs and the TTNs** **1.** None of the PwMs experienced challenges in dealing with the TTNs. They characterised their relationship with them as ‘good’ and ‘friendly’, while the TTNs were characterised as being ‘caring’, ‘empathic’ and ‘understanding’. **2.** The PwMs spoke about following the TTNs’ advice and nine of them reported that they took it because they perceived it to be ‘practical’ and ‘good’, and because they were getting advice from qualified professionals.