An Evaluation of the Feasibility to Use Digital Solutions to Support the Provision of Healthcare in the NHS

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Abstract

In England, there is an increase in prevalence of patients with long-term conditions (LTC) with approximately 26 million people having at least one LTC, utilising 70% of the total health and social budget. The Five Year Forward View and the NHS Long Term plan have identified that digital healthcare is a cost-effective technology that has the potential to integrate systems, improve efficiencies and have better clinical and social outcomes for patients. Whilst the successful implementation of digital healthcare in the NHS has been challenging, the severe acute respiratory syndrome coronavirus-2 (COVID-19) has been a major driver to support the rapid implementation of digital technology to safely maintain services and public health. This thesis aimed to evaluate the feasibility of using digital solutions to support the provision of healthcare in the borough of Croydon.

Overall, a mixed-method approach consisting of quantitative and qualitative techniques was used to investigate the usability and acceptability of three technology enabled care solutions: a telehealth monitoring system in care home with residents with dementia, a follow up telephonic solution post-discharge and a digital stethoscope to screen for congenital murmurs.

The study that assessed the potential role of telehealth system for monitoring residents with dementia living in a care home took place over three six-month phases [control phase (CP), active monitoring phase (AMP) and active monitoring with text alerts (AMTAP)]. The solution involved carers recording vital signs and completing health assessment questions. In AMTAP, the early warning triage system generated text alerts when abnormal responses or vital signs were detected. Twenty-seven residents participated during the CP and AMP whilst only fourteen residents participated during AMTAP. The quantitative section of this study calculated the frequency effect of the telehealth solution on the general practitioner visits (GPV), antibiotic prescribing (AP), emergency department (ED) visits and hospital inpatient (IP) events whilst the qualitative section of this study explored multidisciplinary healthcare professionals (HCPs) awareness and experiences of the telehealth system and reported on their perceptions pre and post implementation. The digital healthcare solution resulted in more frequent monitoring of residents' vital signs (weekly vs monthly) resulting in an increase in frequency of GP ($p=0.009$) and AP ($p<0.001$) and a decrease in ED, IP

and duration of an admission. Multidisciplinary HCPs were interviewed pre-AMP (n=33) and post-AMP (n=28). HCPs working with the digital solution reported increase knowledge and awareness after using the digital solution whereas HCPs who did not have direct contact reported a lack of understanding and awareness. Barriers to implementation included: lack of resources, training, inadequate staffing, equipment failure and poor system implementation. Indirect beneficial outcomes included: improved medication changes for residents and improved professional satisfaction and therefore HCPs wanted to use digital healthcare in the future.

The second study evaluated a post discharge telephonic intervention by two nurses in the role of discharge advocates (DA) to ensure that the patients received the required post discharge care. The intervention was part of a funded project aiming to design a readmission prediction risk score system (OPTIMAL) to identify patients in need of a post discharge intervention to prevent a readmission within 30 days of discharge. The DA recruited eligible patients into the intervention (n=740) and control arms (n=730). It was determined that a sample size of 265 patients' evaluations per a group (total 530, [intervention (n=265) and control (n=265)]) would be needed to determine patients' satisfaction levels at 95% confidence interval. The sample extracted for evaluation had a statistically significant (p=0.001) higher mean OPTIMAL 30-day readmission risk score than the study arms. The OPTIMAL risk score of admission was reflective of the actual rate of re-admission with an average predictive score of 16.28% and actual 30-day readmission rate of 15.12% (n=223) for the whole sample. In the sample tested, the OPTIMAL predictive percentage readmission scores were 20.27% and 20.91% in the evaluation and control arms compared to (n=61, 23%) actual 30 days readmission rate across both arms. There was no significant difference in 30-day readmission rate between the study control and intervention arms. However, the percentage actual readmission rate was statistically significantly lower for the intervention evaluation group (9.4%) as compared to the control evaluation group (13.5%) ($p<0.001$). The DA call was perceived positively by patients as they felt that the DA understood their health status (81.1%) and was quite helpful (82.2%). Based on the findings, perhaps the intervention should not have been offered to all patients but to those that will most benefit from it, so targeted intervention based on the OPTIMAL readmission risk score, as the intervention did statistically significantly lower readmission rate for those patients.

Lastly, an investigation was conducted to evaluate both the feasibility of an electronic stethoscope for the detection of congenital heart murmurs and its usability and associated software amongst clinicians with different levels of experience. Paediatric patients (n=72) with suspected murmurs attending a Paediatric Cardiologist led outpatient clinic and forty age-matched participants with no discernible murmurs consented to 30-second heart sound Consultant Paediatrician verified recordings using a 3M™ Littmann® Electronic Stethoscope Model 3200 to create a heart sound database. MATLAB (The MathWorks Inc., USA) was used to create sound waveforms and the 3M™ Littmann Steth Assist Heart and Lung Sound Visualization Software® was used to record and playback heart sounds. For the recordings without murmurs (n=6), the waveform between heart sounds appeared regular and smooth whereas in the recordings with murmurs (n=6) the waveforms between heart sounds had varying frequency with some higher frequency components. This was apparent with grade 3 and above murmurs, but this was less apparent in grade one and two murmurs, hence not proving a useful tool for screening. Clinicians (n=38) retrospective assessment of heart sounds played through a Bluetooth speaker resulted in system sensitivity of 77% and a specificity of 69%. The ability to distinguish between a normal and abnormal heart sound when listening to the audio samples was related to the experience of the clinician, with consultants scoring the highest. Unfortunately, clinicians (61%) reported that they would not be comfortable to confirm a diagnosis remotely using the system. All clinicians were able to acquire heart sounds using the electronic stethoscope. However, only Consultants (n=11), Senior House Officers (SHOs) and Registrars (n=4) ranked the electronic stethoscope with an acceptable System Usability Scale (SUS) score (≥70). Clinicians identified advantages for the system, with potential use as an educational tool and for the retrospective review of heart sounds.

The three studies above evaluated the feasibility of using digital solutions to support the provision of healthcare. The evaluation has proven that digital solutions have the potential to support HCPs in healthcare provision, but the technology, organisation and patients need to be considered so that the proper ‘digital fit’ can be achieved to ensure that digital solutions are adopted by HCPs and that patients can experience the full benefits from them for both their healthcare and social outcomes.

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Evaluating a digital solution at Albany Lodge, a care home with residents with dementia would have not been possible without the support of the carers, nurses, paramedics, general practitioners, management and most importantly my patients and their families.

Finally, this would have not been possible without my family in South Africa. Your constant support has been a solid foundation that has sustained me through this journey even though we were apart. I will always be grateful.

Statement of Originality

I certify that the thesis presented here for examination for a PhD in Pharmacy at Kingston University is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

I declare that this thesis has been produced in accordance with the Kingston University's Code of Good Practice in Research.

I hereby also declare that no portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or any other institute of learning.

In addition, the role of the author in each chapter is specified as per the ICMJE Recommendations for defining the role of authors and contributors.[1]

Publications, Conferences and Contributions

Peer reviewed journals

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   A cross-sectional survey investigating women's information sources, behaviour, expectations, knowledge and level of satisfaction on advice received about diet and supplements before and during pregnancy
   BMC Pregnancy Childbirth (2018) May 25;18(1):182.

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1. Wertheim, D., **Naicker, K**., Chang, M., Chang, J., Rigby, M., Kumar, A. and Kayyali, R.
   Analysis of heart sounds in children from electronic stethoscope recordings
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Training:

1. *Introduction to Clinician Performed Echocardiography*
   European Academy of Paediatrics, 21st October 2016

Table of Contents

Abstract ..... **i**

Acknowledgements ..... **iv**

Statement of Originality ..... **v**

Publications, Conferences and Contributions ..... **vi**

Table of Contents ..... **vii**

List of Tables ..... **xii**

List of Figures ..... **xiv**

List of Appendices ..... **xv**

List of Abbreviations ..... **xvi**

Chapter 1: Technology Enabled Care Services (TECS) in the NHS **1**

1.1. Background 2

1.2. Technology Enabled Care Services (TECS) 4

1.2.1. TECS and Chronic Obstructive Pulmonary Disease (COPD) 8

1.2.2. TECS and Cardiovascular Disease (CVD) 9

1.2.3. TECS and Diabetes 10

1.2.4. TECS and care for older people, for dementia and those with caring responsibilities 12

1.2.5. Barriers and Benefits of TECS 13

1.2.6. Uses of TECS Data 14

1.2.7. TECS and COVID-19 15

1.2.8. Smart wearable body sensors (SWS) 16

1.2.9. TECS, Precision Medicine and Pharmacogenomics 17

1.3. Classification of Adopters and Chasms 18
1.3.1. Technology Readiness Adoption Model (TRAM) 20
1.4. Theoretical Domains Framework (TDF) 26
1.5. Thesis Rationale 28
1.6. Research Design 29
1.6.1. Study Setting 31
1.7. Thesis Layout 32
Chapter 2: The feasibility of using telehealth in a nursing care home for dementia residents: Healthcare team perceptions and clinical outcomes 34
2.1. Background 35
2.1.1. Definition, Classification, Subtypes and Severity of Dementia 35
2.1.2. Prevalence of Dementia 35
2.1.3. Diagnosis of Dementia 38
2.1.4. Behavioural and Psychological Symptoms of Dementia and their management 40
2.1.5. Management of Dementia 43
2.1.6. Co-Morbidities and hospital admissions associated with Dementia 44
2.1.7. Admissions due to Inappropriate Prescribing and Falls 46
2.1.8. End of Life Care and National Gold Standards Framework 49
2.1.9. Digital Healthcare in Care Homes 51
2.2. Aim and Objectives 56
2.3. Evaluation Methodology 57
2.3.1. Standard Care Pathway 57
2.3.2. Telehealth System (THS) 58
2.3.3. Study Phases and Setting 58
2.3.4. Participant Recruitment Strategy 61

2.3.5. Clinical Outcomes 63
2.3.6. HCP Perceptions 65
2.3.7. Ethical Approval 69
2.4. Quantitative Results 70
2.4.1. Resident Demographics and Past Medical History 70
2.4.2. System Significant Text Alerts 72
2.4.3. Clinical Outcomes 75
2.4.4. Reasons for Hospital Admissions 78
2.4.5. Medicine Optimisation 82
2.5. Qualitative Results 91
2.5.1. HCPs Interviewed 91
2.5.2. Pre-TH Interview Analysis 92
2.5.3. Post-TH Interview Analysis: 96
2.5.4. TH impact on AL Culture 117
2.6. System Usability Scale (SUS) Results 118
2.7. Discussion 119
2.7.1. Future development of the system 126
2.7.2. Limitations and Conclusion 128
2.8. Author Contributions 129
Chapter 3: Preventing Early Hospital Re-Admission using a digital predictive algorithm system (OPTIMAL) 130
3.1. Background 131
3.1.1. Predictive Modelling of Readmissions 136
3.1.2. OPTIMAL 137
3.2. Aim and Objectives 139
3.3. Methods 140
3.3.1 Study design and sample 140

3.2.2. Ethics consideration and consent 142
3.2.3. Data Analysis 143
3.3. Results: 139
3.3.1. Sample size and Demographic data 139
3.3.2. Admission Risk, Duration and Causes 142
3.3.3. Patient satisfaction and experience 155
3.4. Discussion 163
3.4.1. Limitations 168
3.4.2. Conclusions 168
3.5. Author Contributions 169
Chapter 4: The Physicians Ear 170
4.1. Background 171
4.1.1. Foetal Antenatal and Paediatric Postnatal Cardiac Circulation 172
4.1.2. Normal Cardiac Structure and Circulation: Timing and Sounds 173
4.1.3. Cardiac Auscultation, Diagnostic Equipment and Software 175
4.1.4. Cardiac Murmurs 179
4.1.5. Cardiac Telehealth Applications 181
4.1.6. Rationale 182
4.2. Aim and Objectives 184
4.3. Methodology 185
4.3.1. Detection and acquisition of heart sounds of paediatric patients 185
4.4 Results 191
4.4.1. Acquisition and compilation of a database of heart sounds from paediatric patients using an electronic stethoscope 191
4.4.2. Usability of an electronic stethoscope and associated software amongst clinicians with different levels of experience 197
4.5. Discussion, limitations, and future 199

4.5.1. Conclusions 202
4.6. Author Contributions 203
Chapter 5: Conclusions and Recommendations 204
5.1. Research Review 205
5.2. Research Methodology 206
5.3. Key Findings 207
5.4. Limitations 211
5.5. Recommendations 211
5.6. Future Work 213
References 214
Appendices 241

List of Tables

Table 1. 1 Research Design Overview 30

Table 2. 1: Test of Symmetry: Shapiro Wilk p-values 65
Table 2. 2: Pre and Post Codes and Themes 68
Table 2. 3: Summary of Residents Demographics, Comorbidities and Past Medical History during CP, AMP and AMTAP 71
Table 2. 4: Frequency of THS Alerts, Text Alerts and RRT Response per Resident 73
Table 2. 5: Frequency of Significant Alerts per Category 74
Table 2. 6: Frequency of Clinical Outcomes per Phase (n=27) 75
Table 2. 7: Frequency of Clinical Outcomes per Phase (n=14) 77
Table 2. 8: Reasons for Admission (n=27) 78
Table 2. 9: Co-Morbidities/Medical Condition History vs. Reason for Admission (n=27) 79
Table 2. 10: Reasons for Admission (n=14) 80
Table 2. 11: Co-Morbidities/Medical Condition History vs. Reason for Admission (n=14) 81
Table 2. 12: Optimisation Medication per Phase (n=27) 84
Table 2. 13: Optimisation Medication per Phase (n=14) 85
Table 2. 14: Classification of Medication per Phase (n=27) 87
Table 2. 15: Classification of Medication per Phase (n=14) 88
Table 2. 16: CPS Scores 89
Table 2. 17: Falls per Phase 90
Table 2. 18: Summary of Interviewees 91
Table 2. 19: Cultural Changes due to Telehealth 117
Table 2. 20: Average SUS Scores per Participant Category 118

Table 3. 1: Patient recruitment, exclusions and eligibility 139
Table 3. 2: Evaluation types 139
Table 3. 3: Patient demographics: age and gender 140
Table 3. 4: Ethnicity distribution 141
Table 3. 5: Ward Admissions 143
Table 3. 6: Speciality Distribution 144
Table 3. 7: Duration of Patient Stay 146
Table 3. 8: Admission frequency of patients before and during study 147
Table 3. 9: Reason for Admissions 148
Table 3. 10: OPTIMAL readmission risk percentage score 150
Table 3. 11: Mean percentage OPTIMAL readmission score 150
Table 3. 12: Age Groups versus Optimal Risk Groups 151
Table 3. 13: Actual readmission rate 151
Table 3. 14: Causes of readmission within 30 days of discharge 153

Table 3. 15: Readmission versus Original Admission 154
Table 3. 16: Provision of discharge information 155
Table 3. 17: Medication changes at discharge 155
Table 3. 18: Medication counselling before discharge 156
Table 3. 19: Patient reported information about discharge 157
Table 3. 20: Mean scores of patients feeling response scale 157
Table 3. 21: Appointments made by patients 159
Table 3. 22: Patient made appointments post discharge 160
Table 3. 23: Patient perceptions of previous discharge compared to their latest discharge 161

Table 4. 1: Summary data from the two groups of infants 188
Table 4. 2: Summary data from the two groups of paediatric patients 190
Table 4. 3: The demographic data of paediatric patients 191
Table 4. 4: Percentage success of recordings correctly identified 194
Table 4. 5: Effectiveness, remote diagnostic abilities, and limitations of the system 194
Table 4. 6: Thematic frequency analysis of comments 195
Table 4. 7: Telehealth Auscultation Method Comparison 196
Table 4. 8: Usability SUS Scores 197
Table 4. 9: Preferences, Advantages and Limitations of the electronic stethoscope 198
Table 4. 10: Thematic frequency analysis of limitations of the electronic stethoscope 198

List of Figures

Figure 1. 1: Technology Enabled Care and Long-Term Conditions 5
Figure 1. 2: Adapted Graph of Technology Adoption 19
Figure 1. 3: Chasms of Adoption 20
Figure 1. 4:TRAM Model 25

Figure 2. 1: AL Healthcare Professional Stakeholders 54
Figure 2. 2: Care Pathway for Unwell Residents before Telehealth 57
Figure 2. 3: Study Phases 59
Figure 2. 4: Health Information Text Alert Pathway for Unwell Residents 60
Figure 2. 5: Care Pathway for Residents once Text Alert received by Rapid Response 61
Figure 2. 6: Patient Selection Criteria 63

Figure 3. 1: Patient Study Journey 138
Figure 3. 2: Confidence in medication, social care and health status 158
Figure 3. 3: Timing and length of the call 158
Figure 3. 4: DA Actions 159
Figure 3. 5: DA Understanding of patients' health problems 160
Figure 3. 6: Patient's perception of helpfulness of the DA call 161

Figure 4. 1: Cardiac Circulation: Foetal Antenatal and Paediatric Postnatal[343] 173
Figure 4. 2: Cardiac Structure [346] 174
Figure 4. 3: The Cardiac Cycle 175
Figure 4. 4: Analogue (Left) and Electronic (Right) Stethoscopes[355,356] 177
Figure 4. 5: Auscultation Areas[358] 177
Figure 4. 6: Echocardiogram of the four-chambers of a heart[362] 178
Figure 4. 7: Colour Doppler Echocardiography[363] 179
Figure 4. 8: Paediatric Murmurs [345] 180
Figure 4. 9: Waveform recordings of a murmur and no discernible murmur 192
Figure 4. 10: Example of a 2 second section of recording with no murmur 192
Figure 4. 11: Example of a 2 second section of a recording with a grade ≥ 3 murmur 193

List of Appendices

Appendix 1: Tunstall myClinic® Pre-Study Questionnaire for Carers 241
Appendix 2: Tunstall myClinic® Pre-Study Questionnaire for Healthcare Professionals 243
Appendix 3: Tunstall myClinic® Post-Study Questionnaire for Healthcare Professionals 244
Appendix 4: Tunstall myClinic® Frequency of Residents per Medication Class per Phase 248
Appendix 5: Tunstall myClinic® Medication Risk Table Control Phase 252
Appendix 6: Tunstall myClinic® Medication Risk Table Active Monitoring Phase .. 261
Appendix 7: Tunstall myClinic® Medication Risk Table Active Monitoring Phase with Text Alerts 271
Appendix 8: Tunstall myClinic® Healthcare Professional SUS Ratings 278
Appendix 9: Tunstall myClinic® Inductive Qualitative Content Analysis of Focus Groups 279
Appendix 10: Tunstall myClinic® Telehealth Codes and Themes Codebook 280
Appendix 11: Tunstall myClinic® Pre-Telehealth Thematic Networks 282
Appendix 12: Tunstall myClinic® Pre-Telehealth Framework Frequency Matrix 283
Appendix 13: Tunstall myClinic® Post-Telehealth Thematic Network 285
Appendix 14: Cognitive, Functional and Behavioural Assessment Scales[191,192] 439
Appendix 15: OPTIMAL Patient Information Sheet 442
Appendix 16: OPTIMAL Patient Consent Form 445
Appendix 17: OPTIMAL Patient Questionnaire Post Intervention 446
Appendix 18: OPTIMAL Patient Questionnaire- Control Group 451
Appendix 19: OPTIMAL No Contact Patient Questionnaire Post Intervention 454
Appendix 20: OPTIMAL No Contact Patient Questionnaire Control Group 456
Appendix 21: Physicians Ear Patient Information Leaflet 457
Appendix 22: Physicians Ear Consent Form 461
Appendix 23: Physicians Ear Clinical Record Form 464

List of Abbreviations

AL	Albany Lodge
ACP	Advanced Care Planning
AD	Alzheimer's Disease
AMP	Active Monitoring Phase
AMTAP	Active Monitoring with Text Alert Phase
AP	Antibiotic Prescribed
BPSD	Behavioural and Psychological Symptoms of Dementia
CBD	Cerebrovascular Disease
CCG	Clinical Commissioning Group
CCCG	Croydon Clinical Commissioning Group
CP	Control Phase
CPCF	Community Pharmacy Contractual Framework
COPD	Chronic Obstructive Pulmonary Disease
COVID-19	Severe Acute Respiratory Syndrome Coronavirus 2
CPS	Co-Morbidity Pharmacy Score
CUH	Croydon University Hospital
CPS	Co-Morbidity Polypharmacy Score
CRCT	Cluster Randomised Controlled Trial
CQC	Care Quality Commission
CVA	Cerebrovascular Accident
CVD	Cardiovascular Disease
CT	Computer Tomography
DH	Department of Health
DMS	Discharge Medicines Service
DSM	Diagnostic and Statistical Manual
ED	Emergency Department Admissions
EOLC	End of Life Care
FBI	Frontal Behavioural Inventory
FTD	Frontotemporal Dementia
GP	General Practitioner
GPV	General Practitioner Visits
HCPs	Health Care Professionals
ICP	Integrated Care Pathway
ICS	Integrated Care System
IP	Inpatient Admissions
LB	Lewy Body
LBD	Lewy Body Dementia
LTC	Long-Term Condition

MHRA	Medicines and Healthcare products Regulatory Agency
MMSE	Mini-Mental State Examination
mHealth	Mobile Healthcare
MD	Mixed Dementia
MRI	Magnetic Resonance Imaging
NCD	Neurocognitive Disorder
NHS	National Health System
NICE	National Institute for Health and Care Excellence
NIHR	National Institute for Health Research
NPS	Neuropsychiatric Symptoms
NPV	Negative predictive value
PET	Positron Emission Tomography
PD	Parkinson's Disease
PDD	Parkinson's Disease Dementia
PIM	Potentially Inappropriate Medication
PPV	Positive predictive value
QOF	Quality Outcomes Framework
QoL	Quality of Life
QUIS	Quality of Interactions Scale
RCT	Randomised Controlled Trial
RPS	Royal Pharmaceutical Society
RPM	Remote Patient Monitoring
RRN	Rapid Response Nurse
RRT	Rapid Response Team
SIGN	Scottish Intercollegiate Guidelines Network
SDM	Shared Decision Making
SPECT	Single Photon Emission-Controlled Tomography
START	Screening Tool to Alert to Right Treatment
STOPP	Screening Tool of Older People's Prescriptions
TAU	Treatment As Usual
TH	Telehealth
THS	Telehealth System
UTI	Urinary Tract Infection
VaD	Vascular Dementia
WHELD	Well-Being and Health for People with Dementia
WHO	World Health Organization

Chapter 1: Technology Enabled Care Services (TECS) in the NHS

1.1. Background

The National Health System (NHS) in the United Kingdom (UK) was founded in 1948 to provide optimism to an uncertain nation of post war patients.[2] Patients are now living longer and requiring care for more complex issues resulting in an increase demand for services however, the lack of adequate annual investment has resulted in increased gaps of health, wellbeing, care, quality, funding and efficiency.[2] The World Health Organization (WHO) identified that prevention of chronic disease e.g. cardiovascular disease (CVD), diabetes, chronic obstructive pulmonary disease (COPD) and cancer is a vital investment and estimated that 85% of deaths in the UK are due to chronic disease.[3] The largest annual increase (20%) of the UK healthcare budget was in 2020 (£269 billion) of which 70% (£188 billion) accounts for chronic disease expenditure.[4,5]

In 2014, the Five Year Forward View reported a NHS funding deficit of £30 billion a year by 2020/21.[2] The WHO and NHS have identified that digital technology can strengthen the healthcare system by transforming methods of predicting, diagnosing and treating disease and promoting health education to reduce health inequalities.[2,6] In 2019, the NHS Long Term Plan goals included making sure everyone gets the best start in life, delivering world-class care for major health problems and supporting people to age well.[7] In order to achieve these goals, the NHS is focused on empowering both patients and healthcare professionals (HCPs), preventing illnesses and tackling health inequalities, increasing clinical recruitment, enhancing use of data and digital technology and maximising taxpayer investment in the NHS.[7]

Unfortunately, in 2020, a global pandemic was caused by a severe acute respiratory syndrome coronavirus-2 (COVID-19).[8] To minimise viral transmission, the virtualisation of healthcare was implemented using technology enabled care to continue routine care for chronic diseases. The Office for Budget Responsibility (OBR) reported that the impact of pandemic would cost the UK taxpayer an additional £355 billion for the current financial year (April 2020 to April 2021).[9] The UK 2021/2022 healthcare budget will reduce emergency Covid-19 funding by £37 billion resulting in a net NHS additional funding of only £7 billion as we face oncoming additional waves of the pandemic.[10] The increase in NHS investment and usage of digital technology e.g. telehealth (TH) and application (app) based mobile healthcare (mHealth) to

support patient care during the pandemic has been reported.[11,12] To continue this momentum, the UK government has committed £6 million to seven trusts and an additional £250,000 to twenty five other trusts to develop their digital strategies to protect the most vulnerable patients and bolster the NHS.[13] There are fifteen Academic Health Science Networks (AHSNs) across England whose role is to support the accelerated adoption of technology in the NHS.[14] The National Institute for Health Research (NIHR) has developed a patient recruitment centre that contains details of participants who have pre-consented to being recruited for clinical trials.[15] Virtual trials are remote access trials which use digital technology to allow recruitment to and delivery of clinical trials without the patient needing to visit a recruiting site.[15] This is beneficial as the patient might be located remotely from the recruiting site.[15] The NIHR has reported that the patient recruitment centre has been used to deliver a virtual trial (RELIEVE IBS-D trial is testing a new treatment for Irritable Bowel Syndrome with Diarrhoea) 67% faster than previously.[15]

Technology enabled care supported by mobile technology is essential to achieve the goals of both NHS Digital Strategy and the NHS Long Term plan to empower both patients and HCPs to reduce the impact of chronic disease burden and ensure the long-term sustainability of the NHS.

1.2. Technology Enabled Care Services (TECS)

Assistive technology is any item, piece of equipment or system that is used to increase, maintain and improve the functional capabilities and independence of people with cognitive, physical or communication difficulties.[16] e-Health is the delivery of health care using modern electronic information and communication technologies when health care providers and patients are not directly in contact and their interaction is mediated by electronic means.[17] Telehealth (TH) has been defined as preventative, promotive and curative healthcare delivered by a multidisciplinary team over a distance.[18] Whilst both TH and telecare use assistive technology, telecare monitors communication over a distance using a telephone network.[16] WHO defines telemedicine as the delivery of health care services, where distance is a critical factor, by all HCPs using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities.[19] Tele-coaching uses telemedicine to help patients promote changes in behaviour and overcome barriers.[20] mHealth is an abbreviation for mobile health and has been defined by WHO as medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices.[21]

These practices are supported by mobile technologies e.g. short messaging service (SMS), telecommunication frequencies (3G,4G and 5G), global positioning system (GPS) and Bluetooth technology.[21] Technology enabled care services (TECS) (Figure 1.1) has been defined as: “the use of TH, telecare, telemedicine, tele-coaching and self-care in providing care for patients with long-term conditions that is convenient, accessible and cost-effective.”[22] TECS has the ability to empower patients to take ownership of their care and supports and encourages the innovative use of technology to improve health outcomes for patients with long term conditions (LTCs) and deliver more cost effective services.[22] Multimorbidity is the diagnosis of one or more non-curable LTCs and has a prevalence of 27.2%.[23] TECS has been reported to improve patient outcomes and cost-effectiveness of care in COPD, diabetes, congestive heart failure (CHF), and CVD using TH.[22,24–27]

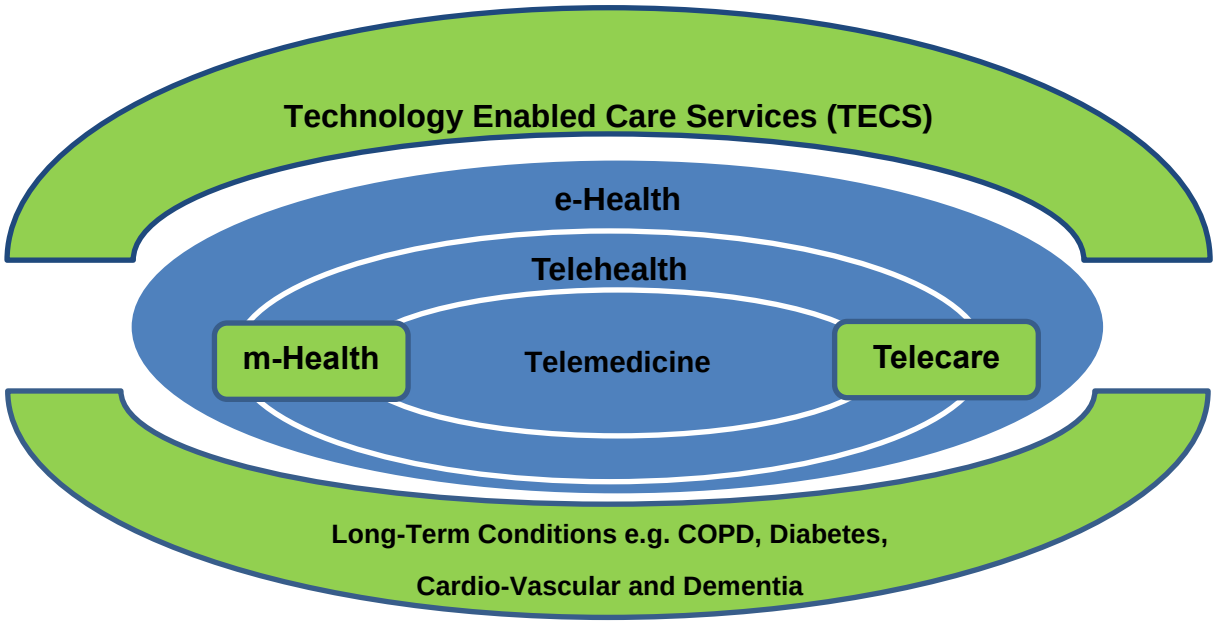

Figure 1. 1: Technology Enabled Care and Long-Term Conditions[18]

In 2003, a systematic review of 306 citations and abstracts reported that TH studies have not used socioeconomic indicators consistently, however, specific TH applications have been shown to offer significant socio-economic benefit, to patients and families, health-care providers and the health-care system.[28] The main benefits identified were: increased access to health services, cost-effectiveness, enhanced educational opportunities, improved health outcomes, better quality of care, better quality of life (QoL) and enhanced social support.[28] In 2010, however, a systematic review (36 articles) of the economic analyses of TH services using real time video communication outlined that 61% (n=22) of studies reported a reduced cost of care using TH whilst 31% (n=11) reported an increased cost and 9% (n=3) equivalent or mixed results concluding that using real time video communication was cost-effective for home care and on-call hospital specialists services but had mixed results for rural service delivery and was not cost-effective for services between hospitals and primary care.[29] This review highlighted the importance of evaluating the design of TH systems (THS) e.g. level of care, clinical discipline and the type of technology to ensure cost-effectiveness.[29]

The Whole System Demonstrator (WSD) is the largest TH randomised clinical trial (RCT) and included 3230 (1625 control and 1605 intervention) participants with similar baseline characteristics including diabetes, COPD, or heart failure recruited from 179 general practices in three areas in England.[30,31] This RCT was conducted by the Department of Health (DH) between May 2008 and November 2009 and has proven that successful implementation of TH after 12 months has resulted in lower admission

rates (odds ratio 0.82, 95% confidence interval 0.70 to 0.97, P=0.017), lower mortality rates (4.6% v 8.3%; odds ratio 0.54, 0.39 to 0.75,P<0.001) and shorter length of stay in hospital (mean bed days per head 4.87 v 5.68; geometric mean difference −0.64 days, −1.14 to −0.10, P=0.023).[30,31] A Cochrane Review (22 studies, 5057 lesions, 879 malignant cases) reported that TH had a high diagnostic sensitivity (94.9%) and specificity (84.3%) in accuracy of diagnosis of dermatological conditions.[32,33] A systematic review of 38 TH systematic reviews and meta-analyses (908 studies) of the clinical effectiveness of TH versus standard care from 2010 to 2019 in 10 medical disciplines reported that TH was as effective, if not more, than standard of care.[32]

In 2013, a systematic review and meta-analysis of mobile technology-based health interventions to improve healthcare service delivery in high income countries included 42 trials to increase support to HCPs (32 trials, n=5323) and to improve communication between patients and health services (10 trials, n=4473). Mobile technology interventions increased HCP support resulting in improved clinical diagnosis and treatment (18 trials) and HCP communication (7 trials), mixed process related outcomes and reduction in clinical assessments using mobile photography (2 trials) and EGC mobile quality (1 trial). Short message service mobile technology provided modest benefit (Relative risk=1.06, Range= 1.05–1.07) to increase clinic attendance.[34] Outpatient monitoring has been approached using three models: patient reported outcomes (PRO), telemonitoring and quantifying self-hybrid models (QSHM). Whilst PRO only generates subjective data, telemonitoring uses equipment to generate qualitative physiological data. QSHMs are a hybrid of the two models allowing integrated analysis of subjective symptoms with objective physiological data.[35]

A 2015 UK multicentre survey study of doctors (n=2107) and nurses (n=4069) reported that most doctors (98.9%, n=2084) and most nurses (95.1%, n=3870) own a smartphone and that doctors (73.5%, n=1549) and nurses (64.7%, n=2633) owned a tablet device.[36] This study also reported that doctors (92.6%, n=1951) and nurses (53.2%, n=2165) found their smartphone to be ‘very useful’ or ‘useful’ in helping them to perform their clinical duties and that doctors (89.6%, n=1888) and nurses (67.1%, n=2730) were using medical mobile applications as part of their clinical practice.[36] Mobile functions used included SMS for doctors (64.7%, n=1363) and nurses (13.8%, n=562), app-based messaging for doctors (33.1%, n=702) and nurses (5.7%,

n=231.93) and picture messaging for doctors (46.0%, n=969) and nurses (7,4%, n=301).[36] Doctors (71.6%, n=1509) and nurses (37.2%, n=1514) also reported that they desired a more secure means of mobile communication to send patient related information to their colleagues.[36] These results created a solid platform to promote mHealth in the healthcare sector.

In 2017, a systematic review and narrative analysis of 44 articles reported that TH improved patient satisfaction due to the following effectiveness and efficiency factors: improved outcomes (20%); preferred modality (10%); ease of use (9%); low cost (8%); improved communication (8%) and decreased travel time (7%).[37] This study also reported that their results were consistent with other systematic reviews in that whilst older patients generally do not embrace change, they have identified a generational (55 to 87 years) acceptance of technology and mHealth.[37,38] Evidence of TECS in COPD, CVD, diabetes and mental health is discussed below.

1.2.1. TECS and Chronic Obstructive Pulmonary Disease (COPD)

COPD is an irreversible lung disease resulting in an increased incidence of dyspnoea, respiratory tract infections, unplanned and longer hospital admissions and increased morbidity and mortality.[39] COPD costs the NHS £1.9 billion annually.[40]

A systematic review and meta-analysis in 2010 (9 studies, n=858) reported that home TH (home telemonitoring and telephone support) for COPD reduced emergency department (ED) and hospitalisation admissions. Length of stay was not consistent and mortality was greater in the home TH group than the usual care group (risk ratio=1.21; 95% CI: 0.84 to 1.75).[41] A Cochrane review and meta-analysis of 10 randomised controlled trials (RCTs) (n=1307) in 2012 reported that TH interventions can significantly reduce the risk of ED attendance (Odds ratio (OR) = 0.27; 95% CI = 0.11 to 0.66) and hospitalisation (OR = 0.46; 95% CI = 0.33 to 0.65) but had a non-significant change on the risk of death (OR = 1.05; 95% CI = 0.63 to 1.75).[42] Another systematic review and meta-analysis (9 studies, n=982) of the effect of TH in COPD on physical outcomes and dyspnoea reported that TH may lead to a significant increase in physical activity (mean differences (MD)=64.7 min, $p<0.001$) but no difference in physical capacity (MD=-1.3 m, p=0.708) or dyspnoea (standardised mean differences (SMD)=0.088, p=0.232).[43] Odeh et al.[44] reported that TH decreases accident and ED (36%, p=0.03) and hospital admissions (28%,p=0.02) for COPD and heart failure patients (n=48) when only the events directly related to the patient's diagnosed condition were considered. Patients (n=27) reported that TH had improved their health, was more convenient and they felt more involved, empowered and confident in managing their health.[44] Gaveikaite et al.[45] have published a study protocol to update the knowledge on efficacy of TH interventions in management of patients with COPD so that clinicians can select the most effective TH intervention for the different COPD severity groups to improve COPD management.

Overall, there is evidence that TH compared to standard care can reduce ED visits, unplanned hospital admissions and dyspnoea and cost of disease burden .

1.2.2. TECS and Cardiovascular Disease (CVD)

A systematic review and meta-analysis (21 RCTs, n=6317) in 2013 reported that compared to usual care, TH remote monitoring reduced mortality when delivered during office hours (24%, hazard ratio (HR)=0.76,CI=0.49-1.18), when delivered 24/7 (51%, HR=0.49, CI=0.20-1.18) or using structured telephone support home monitoring system (23%, HR=0.77, CI=0.55-1.08). TH remote monitoring reduced hospitalisation for all causes when delivered during office hours (25%, HR=0.75, CI=0.49-1.10) and 24/7 (19%, HR=0.81, CI=0.33-2.00). Structured telephone support home monitoring system reduced heart failure related hospital admissions (23%, HR=0.77, CI=0.62-0.96).[46] Only one multicentre study reported a statistically significant reduction in the length of hospital stay among the structured telephone support group (Average: 6.6 vs 11.0 days, p<0.001).[47] Three studies reported significant improvements in physical (p=0.03) and overall measures (p<0.001) of QoL.[48–50] A previously cited review (3 systematic reviews and meta-analyses of 25 studies) reported that TH reduced inappropriate implantable cardioverter-defibrillator shocks, reduced major thromboembolic events, increased the timeliness of event detection and improved overall CVD outcomes.[32] Home blood pressure telemonitoring (n=60) has been proven to significantly increase adherence to home blood pressure monitoring using a visual analog scale (VAS; score 0-100) as a measure of the motivation to perform measurements (12.8 ± 3.3 vs -1.6 ± 2.2, P = 0.001) and reduce both morning systolic (-5.5 ± 0.9 mm Hg vs 0.7 ± 0.7 mm Hg, P < 0.001) and evening diastolic blood pressure (-4.6 ± 1.0 mm Hg vs 1.0 ± 1.1 mm Hg, P < 0.001) when compared to the control group.[51]

The 2016 European Guidelines on Cardiovascular Disease Prevention in Clinical Practice recommends that monitoring and controlling modifiable CVD risk factors e.g. smoking, high blood pressure, diabetes, physical inactivity, being overweight and high blood cholesterol can change clinical outcomes.[52]

In 2018, Coorey et al.[53] conducted a systematic review and meta-analysis to evaluate the effectiveness, acceptability and usefulness of mobile applications for cardiovascular disease self-management. This review included 10 studies, 607 patients from 5 countries and focused on interventions that targeted hypertension, heart failure, stroke and supported cardiac rehabilitation. Users of mobile applications designed to improve and maintain at least two lifestyle behaviours e.g. increased

physical activity or smoking cessation and treatment adherence e.g. using interactive self-monitoring features reported to experience an improvement in blood pressure, body mass index, cholesterol and exercise capacity, disease-specific knowledge, medication adherence, psychosocial well-being, physical activity, QoL re-hospitalisation rates, waist circumference and smoking cessation.[53] Reported desired mobile application features included disease education, personalised customisable content, self-monitoring and tracking healthy behaviours.[53] This systematic review concluded that mobile applications have the potential to modify multiple behaviours and reduce cardiovascular risk factors in the shorter term.[53] Therefore, similar to COPD, with regards CVD, telehealth compared to standard care, has been shown to decrease incidence of hospital admissions, mortality and increases health monitoring adherence and QoL.

1.2.3. TECS and Diabetes

Whilst 7% of the UK population are diagnosed with type 2 diabetes including 40 000 children increasing by 3000 annually, approximately one million people are undiagnosed and Diabetes UK is predicting 5.5 million cases by 2030.[54] Type 1 (57%) and type 2 (42%) diabetes patients are not receiving all eight annual health checks.[55] Type 1 (49%) and type 2 (90%) diabetics are offered structured education but only 7.9% and 10.4% respectively attended. The clinical impact of diabetes includes reduced psychological well-being (40%), microvascular complications (33%) resulting in weekly amputations (n=175) and myocardial infarctions (n=530) respectively. Diabetes cost the NHS £10 billion annually (10% of total budget) of which 80% is spent on treating complications.[54]

A 2008 systematic review and meta-analysis (26 studies, n=5069) reported that home TH for diabetes management improved glycated haemoglobin (HbA1c) levels (weighted mean difference=-0.21; 95%CI=0.35 to 0.08).[50] Studies reported that home TH resulted in a reduction in hospitalisation (3 studies) and length of stay (3 studies) but an increase in ED (1 study) and primary care (1 study) visits.[50] Another 2019 systematic review and meta-analysis (38 studies, n=6855) reported that telemonitoring was successful in the provision of monitoring support and customised advice for diabetic patients and increased (1.8 times higher) HbA1c control (<7%), systolic blood

pressure (weighted mean difference –1.33mm Hg) and body mass index (weighted mean difference –0.25 kg/m^2).[56] Su et al.[57] conducted a meta-analysis of 92 studies in 2016 and reported that whilst TH significantly reduced HbA1c (Hedges' g=0.676, SE=0.060, p<0.001), the inclusion of nutritional counselling did not significantly reduce HbA1c (g=0.684 vs. 0.661).[57] Remote monitoring of HbA1c was supported with videoconference, telephone, email, text message and other technologies.[57] However, a systematic review (23 studies, n=2526) and meta-analysis (18 studies) in 2019 reported that mobile phone apps were significantly effective in lifestyle modification resulting in improved HbA1c levels in type 2 diabetics (-0.3, p<0.001, CI=-0.43 to -0.17).[58] A more recent systematic review (6 studies, n=1400) in 2020 reported that mobile health technology versus standard care was effective in the prevention of type 2 diabetes by significantly reducing weight (-6.2kg vs. 0.3kg, p<0.001), body mass index (BMI) (-2.2kg/m^2 vs.0.1kg/m^2, p<0.001), systolic blood pressure (121.1mmHg vs 129mmHhg, p<0.05), fasting blood glucose (-0.41 vs. -0.12, p<0.001), HbA1c (-0.26% vs. -0.18%, p<0.001) and improving triglyceride to high-density lipoprotein ratio (–0.21 vs. 0.21, p=0.04), diet patterns and physical activity.[59] A multi-centre multi-phase international six month study investigated the feasibility of a portable pancreas system in patients (n=14) with type 1 diabetes mellitus. Participants were successfully monitored and treated using a continuous glucose monitoring closed looped insulin delivery system supported by a cloud-based ecosystem via a mobile phone compared to their baseline observation period. The frequency of hypoglycaemia below 3.9 mmol/L during a period of 3 months was lower: 4.1% versus 1.3%, P< 0.001 and HbA1c decreased from 7.2% (55 mmol/mol) to 7.0% (53 mmol/mol) at 6 months. HbA1c improvement was correlated with system use (Spearman r= 0.55). Users reported a favourable experience with benefits at night and overall trust in the system as there were no serious adverse events, severe hypoglycaemia, or diabetic ketoacidosis.[60,61]

1.2.4. TECS and care for older people, for dementia and those with caring responsibilities

Zarit et al.[62] reported that caregivers of individuals with dementia had reduced feelings of burden when other relatives paid more visits to dementia patients thus identifying the need to support caregivers in the community care of elderly persons with dementia. The Caregiver Burden Scale is a simple instrument composed of 22 questions grouped into five dimensions (general tension, isolation, disappointment, emotional involvement and environment), covering important areas for caregivers, such as health, mental wellbeing, personal relationships, physical overload, social support, finances and home environment.[63]

A systematic review (65 studies) reported that TH interventions (education, consultation including decision support, psychosocial/cognitive behavioural therapy including problem solving training, social support, data collection and monitoring, and clinical care delivery) improved caregiver outcomes and that caregivers were satisfied and comfortable with TH support for chronic disease care, home and hospice care. The outcomes included enhanced psychological health (less anxiety, depression, stress, burden, irritation and isolation) (44%), higher satisfaction/confidence/preference/comfort/use with TH (38%), improved caregiving knowledge/skills/patient management (20%), higher QOL (12%), more social support/social function/need met (14%), improved coping/problem solving skills/goal attainment/decision-making (8%), better communication with providers (5%), more cost saving (5%), enhanced physical health (2%) and productivity (2%).[64]

A recent systematic review (17 studies) in 2021 reported that telemedicine compared to in-person visits, was successfully implemented by staff and care partners to support routine care, cognitive assessment and diagnosis and telerehabilitation outcomes of dementia. The challenge of hearing difficulty was reported by telemedicine participants (6 studies) and 5 studies excluded participants with visual or hearing impairment to avoid difficulties in using telemedicine technology. Limitations included that no studies reported technological adaptations to account for sensory impairment as it is highly prevalent in elderly people with dementia.[65] Lisk et al.[66] reviewed 1954 UK hospital admissions from 6 nursing homes in 2019 and reported that telemedicine administered by a geriatrician had a significant reduction in admissions (2.59 vs 5.41, $p<0.05$), length of stay (33 vs. 57 days, $p<0.05$) in hospital and cost saved (£74,383) and thus

concluded that geriatricians working together with co-ordinated multidisciplinary teams are well placed to manage the care needs of frail and elderly care home residents. On another hand, another recent systematic review (30 studies, n=6,882) in 2020 reported that there is a lack of robust evidence to support the use of TH in both normal and out of hours palliative care due to poor study design and evaluation technique.[67] However, a recent study reported that during the pandemic, a TH TV tailored support system for participants with mild dementia (n=93) was successful in promoting physical and mental health, due to receiving COVID-19 updates (n=89, 97%) and performing more mental exercises (24/93, 52% vs 8/93, 17.4%; P<.001).[68]

Thus TH compared to standard care has been proven to be beneficial not only to patients but also their caregivers. Telemedicine is a cost-effective tool that supports timely clinical escalation and improves the quality of care to patients with dementia. However, the technology and studies need to be adapted to participants.

1.2.5. Barriers and Benefits of TECS

Despite the ideal environmental factors and motivation to adopt TH and mHealth into current practice, several studies have identified barriers to the successful implementation of TH including high cost and lack of funding and resources, organisational support, stringent patient inclusion criteria, technical support and health professional uncertainty.[44,69,70] In addition, there are misconceptions about the use of TH previously reported in studies including loss of face-to-face contact with patients and vital care information in addition to lack of belief and confidence in using technology.[44,69–71] Misconceptions of technology are a chasm in the successful adoption of TH and mHealth whilst perceived ease of use and perceived usefulness are drivers of successful technology adoption. Several systematic reviews have reported an increase in the adoption of TH and mHealth during the pandemic. Benefits reported were reduced: diagnosis waiting times, cost of treatment, bed occupancy, HCP workload, and exposure to contagions e.g. COVID-19 and increased: treatment availability.[11,12] A systematic review of 2700 patients (n=35 articles) reported that 91% (n=32 articles) of articles identified that videoconferencing and telephone based voice evaluations were as effective as in-person consultants in treating otolaryngology patients.[72] Video-otoscopy was also reported as most favourable intervention to

improve social distancing between HCPs and their patients during a pandemic, and TH facilitators (healthcare staff and GPs that supported the collection of images for transmission) play a key role in proving high quality TH services.[72] On the other hand, another systematic review of 23 studies reported that patients with a limited English proficiency consistently favoured in-person professional interpreting followed by videoconferencing. Interestingly, telephone interpreting was least preferred.[73] These results were even more valuable due to the increase in remote healthcare consultations over the COVID-19 pandemic and provide timely evidence to healthcare policy and decision makers.[73]

1.2.6. Uses of TECS Data

In the US, Pew's national TRACKING for Health 2012 national survey (n=3014) reported that most people (n=208, 69%) track health indicators for themselves or others and that most people (62%) living with two or more chronic conditions are significantly more likely to track a health indicator or symptom in their heads (49%), on paper (34%) and using technology (21%) and that this has affected their overall approach to maintaining their health (56%), ask a doctor new questions or to seek a second opinion (53%), and affected a decision about how to treat an illness or condition (45%). Smartphone owners (19%) have downloaded a mobile application for exercise (38%), diet (31%) and weight (12%) and people with two or more chronic conditions are more likely to update their notes on a regular basis (54%) and share their results with their clinician (43%).[74] In 2021, Pew [75] reported that whilst most Americans (81%) want to share and access more digital healthcare information on smartphones, tablets, and computers, 62% expressed serious privacy concerns as federal privacy protections do not cover data stored on apps. In the UK, Statista (n=1702) has reported an increase in smartphone usage (2012 to 2020) in people aged (years): 16-24 (86% to 98%), 25-34 (75% to 98%), 35-44 (71% to 98%), 45-54 (46% to 95%),55-64 (9% to 87%) and 65+ (3% to 65%).[76] The increased usage of mobile technology and mobile health applications creates a platform to increase mobile technology interventions in healthcare as outlined in sections below.

1.2.7. TECS and COVID-19

The COVID-19 pandemic has presented several challenges to the healthcare system. Healthcare services were overwhelmed with the acute care of COVID-19 infected patients whilst trying to maintain essential services for long-term conditions. These challenges presented the need to re-invent, re-organize and transform healthcare and co-ordinate clinical services both at a national and local level to treat COVID-19 infected patients, control outbreaks whilst continuing the care of patients with long-term conditions.

A systematic review (247 studies) has reported that most frequent digital health solutions used during the pandemic included: artificial intelligence (n=111, 44.9%), big data (n=89, 36.0%), internet of things (n=5, 2.0%), TH including mHealth apps and web-based solutions (n=99, 40.1%), digital platforms for communication (n=27, 10.9%), digital solutions for data management (n=4, 1.6%), digital structural screening for COVID-19 therapies (n=22, 8.9%).[77] Another qualitative systematic review (64 studies) reported thirteen barriers and challenges to TH services during the COVID-19 pandemic including: adequacy and accuracy of subjective patient assessment and accuracy of tele-tools, changes in physician-patient communication, technology acceptance and user adoption, data privacy and security, system design, resource availability/accessibility, technical issues, standards and legal considerations, insurance policies and reimbursement, data availability and accessibility, system maintenance, presence of parallel systems and different operational requirements in organisations and lack of widespread use.[78] In the UK, NHS Digital developed a shielded patient list to allow access to both hospital and community health data within seven days of data generation and supported sharing of health data between national clinical trials e.g. Randomised Evaluation of COVID-19 Therapy (RECOVERY) and Genetics Of Mortality In Critical Care (GenOMICC).[79] NHS Digital has also developed the UK COVID-19 community clinical treatment algorithms for all community services.[80] The NHS has released two mobile applications that have supported the NHS Test and Trace service to minimise outbreaks and allow people to have an online record of their vaccination status to promote safe travelling.[81,82] A study that reviewed COVID-19 mobile applications using the Systems Wide Analysis of mobile health-related technologies (SWAT) tool and the NHS Digital Assessment Questionnaire reported that mobile applications from national health organisations e.g. NHS and

WHO achieved the highest scores e.g. NHS24 and COVID-19 app scored 32 out of 38. The effectiveness of a contact tracing app is dependent on a high level of user uptake, supporting technologies e.g. Bluetooth and accuracy of data input by users. User uptake was influenced by concerns around safety and privacy of using mobile applications and therefore some countries e.g. the UK have ensured that mobile applications meet a high level of compliance with General Data Protection Regulation legislation. This includes asking for permission to collect, store, and share anonymised data without personal identifiable information and allowing users to withdraw their personal information from the app at any point.[83]

The COVID-19 pandemic has successfully accelerated the implementation of TECS e.g. TH and mobile applications setting a foundation for enhanced future applications of TECS to support cost-effective quality sustainable healthcare.

1.2.8. Smart wearable body sensors (SWS)

A review of 67 articles on smart wearable body sensors (SWS) for patient self-assessment and monitoring was conducted in 2014. The review outlined that sensors in use can detect speed, distance, steps taken, floors climbed and calories burnt and can monitor physiological data e.g. blood oxygen saturation (SpO_2), heart rate, blood pressure, body temperature. SWS can be used to perform electrocardiograms (ECGs), detect falls and seizures, monitor glucose levels and prothrombin time.[84] Studies have reported that patients should be involved in the design of SWS to aid their implementation into daily worn items e.g. vests, watches and shoes to improve user adherence. SWS offers patients the opportunity to switch from invasive to non-invasive monitoring systems and improve patient adherence e.g. COPD vest or wireless smart contact lenses that monitor glucose levels and automate treatment.[84–87] A systematic review (35 studies, n=700) has reported that mobile phones have built in sensors that offer a low cost opportunity to passively monitor accelerometery, location, sleeping patterns and usage of data to detect changes in behavioural patterns and promote healthier behaviour and increase patient accountability.[88] Project Breathe is a collaboration between Royal Papworth Hospital, the Cystic Fibrosis Trust, the University of Cambridge and Microsoft Research and BREATHE UK that offers cloud-based health monitoring with inputs from a mobile application and

TH home devices e.g. FitBit, thermometer and spirometer. The combination of real-time cloud monitoring, and real-world data has prevented unnecessary clinic visits, identified clinical decline 11 days earlier than standard care and protected patients lungs from long-term ongoing damage.[89] Multiple low-cost mobile phone sensors offer the ability to capture data that can be aggregated to develop predictive algorithms that can act as early warning systems to users to support behavioural change towards healthier outcomes.

1.2.9. TECS, Precision Medicine and Pharmacogenomics

Precision medicine (PM) is a medical model that proposes the customisation of healthcare, with medical decisions, treatments, practices, or products being tailored to a subgroup of patients, instead of a one-drug-fits-all model.[90] The NHS Genomic Medicine Service aims to sequence 500,000 genomes by 2024 as part of routine care to support the early detection and treatment of genetically driven chronic diseases e.g. familial hypercholesterolaemia and empower patients to make informed decisions about their care.[91] Retrospective pattern analysis of physiological data (blood pressure, respiration rate, heart rate, and body weight) from the myHeart® telemonitoring study (n=41 patients,15 heart failure decompensation events and 26 normal conditions) was used to develop a heart failure decompensation events prediction mechanism.[92] Pharmacogenomics is a part of PM. Pharmacogenomics is the study of how genes affect a person's response to specific drugs.[93] The increase use of mobile technology and TH by HCPs and patients especially during pandemic follow the trend of increased connectivity through social media and mobile devices. There is potential for mobile health data to be combined with both genomic and pharmacogenomic data to improve treatment strategies for preventing and managing chronic diseases.[94]

1.3. Classification of Adopters and Chasms

In 2000, Parasuraman [95] proposed a 36 item four-dimension index to measure readiness of adopters to embrace new technology called Technology Readiness Index 1.0 (TRI 1.0). Optimism and innovativeness are drivers of technology readiness, whereas discomfort and insecurity are inhibitors.[95] A year later, Parasuraman and Colby [96] classified technology customers into five clusters: explorers, pioneers, sceptics, paranoids, and laggards. Rogers[97] defined the five stages of adoption to include knowledge, persuasion, decision making, implementation and confirmation in 2003. He has also identified five attributes that influence adoption namely: relative advantage, compatibility, complexity, trialability and observability.[97]

Figure 1.2. below merges Rodger's S-curve of adoption with his categories of adopters.[97] When new technology is available, a small user group (2.5%) of innovators will adopt the technology. As time proceeds, they will be followed by the early adopters (13.5%), early majority (34%), late majority (34%) and laggards (16%). Critical mass is the point in the adoption curve where technology adoption becomes self-sustaining. In 2004, Tsikriktsis[98] validated four (explorers, pioneers, sceptics, and laggards) of the five clusters that Parasuraman and Colby[96] proposed in 2001 but found no evidence of the existence of paranoids. Tsikriktsis[99] also conducted a multiple discriminant analysis that yielded two canonical functions (regression equations/themes) namely technological positivism and technophobia and reported that users wanted to use mobile technology to access e-mail, the Internet, check account balances online and online news.

In 2015, Parasuraman and Colby[98] developed the Technology Readiness Index 2.0 (TRI 2.0) which maintained the 4 dimension index but redefined and reclassified adopters using a 16 item scale into: sceptics (38% - tend to have a detached view of technology, with less extreme positive and negative beliefs), explorers (18% - tend to have a high degree of motivation and low degree of resistance), avoiders (16% - tend to have a high degree of resistance and low degree of motivation), pioneers (16% - tend to hold both strong positive and negative views about technology) and hesitators (13% - stand out due to their low degree of innovativeness).[98]

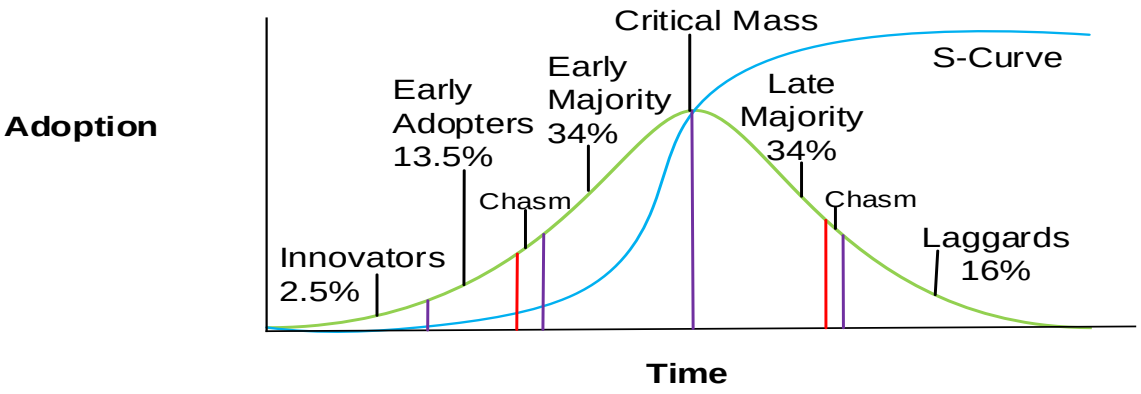

Figure 1. 2: Adapted Graph of Technology Adoption [97,98]

Figure 1.3. represents major chasms that prevent technology adoption which have been previously classified into four integrated categories: design, management, organization, and assessment.[100] The goals of using technology to increase both the efficiency and effectiveness of healthcare whilst decreasing costs and risks can be compromised by chasms. Whilst design has been previously guided by specific fields e.g. human factors and cognitive engineering and human-technology interaction,[101] there is a need for the "convergence of tool and practice" in design, that is, both the technology and humans must adapt features and workflow practices respectively to form an optimal design.[102] Capacity is the organisations ability to provide training, support and the flexibility to adapt implementation plans to changes in the environment, that is, context.[100] Management chasms include both capacity and context.[100] Organisation chasms exists on both a micro level e.g. user frustrations and macro level e.g. conflicting organisational priorities.[100] Assessment includes implementation readiness, level of integration of the four chasms as outlined in Figure 1.3 and feedback and communication.[100]

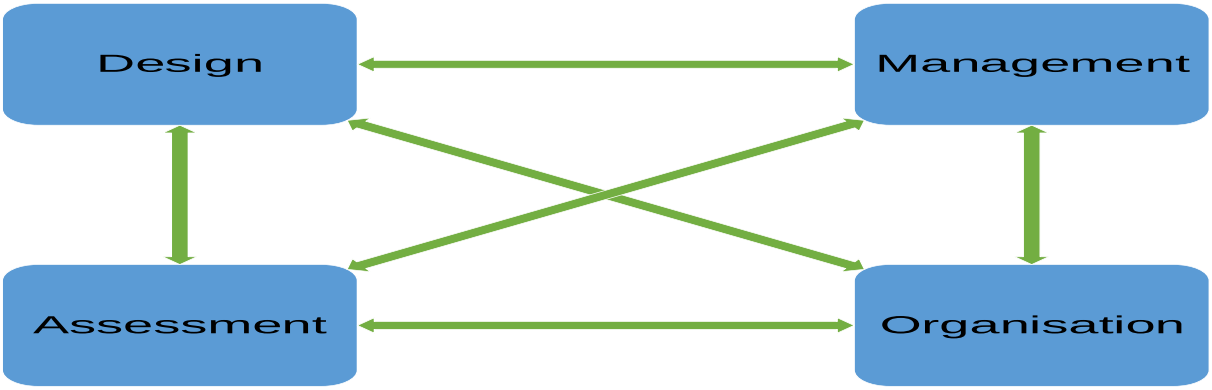

Figure 1. 3: Chasms of Adoption [100]

1.3.1. Technology Readiness Adoption Model (TRAM)

In 1958 Kelman [103] and in 1959 French and Raven [104] proposed that a user's social influence consisted of compliance (user accepts influence to achieve a favourable reaction), internalisation (user incorporates an important referent opinion on whether the user should use the technology, into their own beliefs) and identification (user accepts influence to establish or maintain a satisfying self-defining relationship). In 1971, Triandis [105] defined attitude as an idea charged with affect that predisposes a class of actions to a particular class of social situations. In 1980, Triandis [106] differentiated the impact of beliefs on immediate action and long term consequences.

In 1986, Fred Davis [107] developed the Technology Adoption Model (TAM 1.0). Davis's core model predicted that actual use of technology is directly influenced by intention of use and perceived usefulness (PU) of technology and indirectly influenced by perceived ease of use (PEOU), PU, and attitude.[107] TAM was derived by previous theories in human behaviour, sociology and psychology including Behavioural Decision Theory (BDT) (1968), Social Cognitive Theory (SCT) (1977) and Theory of Reasoned Action (TRA) (1975) which was used to develop the Theory of Planned Behaviour (TPB) (1985) as shown in Figure 1.4.[108–111] BDT influenced PEOU initially through anchoring (general beliefs e.g. objective usability and perceived enjoyment) and then in time through adjustments (beliefs based on experience with technology e.g. anxiety, perceived behavioural control, perceived playfulness and self-efficacy) and is thus considered an important heuristic decision making theory that supports users.[108]

Based on Triandis [106], in 1991 Thompson et al.[112] proposed that personal computer (PC) utilisation is dependent on job fit (the extent to which an individual believes that using a technology can enhance the performance of his or her job), long-term consequences (outcomes that have a pay-off in the future), social factors (the individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations), job relevance (the capabilities of a system to enhance an individual's job performance) and facilitating conditions (provision of support for users of PCs may be one type of facilitating condition that can influence system utilisation).

Interestingly, in 1989, Davis et al.[113] replaced attitude with behavioural intention. However in 1999, Malhotra et al.[114] reported that social influence generated negative attitudes through compliance, resulted in decreased expected use of technology and positive attitudes through internalisation and identification resulted in an increase in expected use of technology. Based on the above, Malhotra [114] concluded that Kelman's [103] constituents of social influence have direct effects on the users' attitude and indirect effects on their behavioural intention via attitude and thus attitude has been included in the proposed model in Figure 1.3. Interestingly in 1994 Barki et al.[115] reported that subjective norm had a significant effect on intention in mandatory but not in voluntary settings and that its effect on PU and intention will decrease in time as the user increases technology experience.[115,116]

In 1992, Davis et al.[117] further supported TAM 1.0 using the Motivational Model and reported that both extrinsic (users will want to perform an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions) and intrinsic user motivation (users will want to perform an activity for no apparent reinforcement other than the process of performing the activity per se) influenced technology adoption and use. Interestingly, usefulness and enjoyment accounted for 62-75% of the mediation effect of PEOU and perceived output quality on the variance of intentions of use.[117]

The concept of self-efficacy (beliefs about outcomes may be insufficient to influence behaviour if users doubt their capabilities to successfully undertake behaviours) was derived from SCT.[109] Interestingly in 1995, Igbaria et al.[110] reported that self-efficacy had a strong direct effect on PEOU but indirect effect on PU. Thus, TRA introduced

subjective norm (users perception of people that are important to the users on whether they should or should not perform the behaviour in question) which directly influences PU and intention of use.[110] TPB added Perceived Behavioural Control (PBC) (the perceived ease or difficulty of performing the behaviour) to TRA.[111] In 1995, Taylor et al.[118] combined various TPB determinants including attitude, subjective norm and PBC with TAM.

In 2000, David and Venkatesh [116] introduced TAM 2.0 which included subjective norm, voluntariness (the degree to which use of the innovation is perceived as being voluntary, or of free will) and image (the degree to which use of an innovation is perceived to enhance one's image or status in one's social system) within the construct of social influence.[103,104,116,119,120] TAM 2.0. also grouped job relevance (the capabilities of a system to enhance an individual's job performance), output quality, PEOU and results demonstrability (the degree to which the results of adopting/using the information system innovation are observable and communicable to others) as cognitive instrument processes.[112,116] TAM is based on the assumption that the relationship between usage and satisfaction and usage and performance is positive and thus further research was recommended to verify the reliability and validity of this assumption.[121] Another recommendation is that TAM 2.0 needs to test the moderating effects of age-related cognitive variables (spatial reasoning, processing speed and memory ability) as Arning and Ziefle [122] have reported in 2007 that age related decline in cognitive abilities are strong predictors of a decrease in performance, PU and PEOU and hence result in a decrease in adoption and use of technology.

In 2003 Venkatesh et al.[123] developed a Unified Theory of Acceptance and Use of Technology (UTAUT) as shown in Figure 1.4. The UTAUT explains 70% of the variance in intention and has 4 core determinants (performance and effort expectancy, social influence and facilitating conditions) and 4 moderators (gender, age, experience and voluntariness of use).[123] Behavioural Intention is influenced by performance and effort expectancy and social influence. Behavioural Intention and facilitating conditions influence behavioural use.[123]

Gender moderates performance and effort expectancy and social influence.[123] This was also supported by Gefan and Straub[124] in 1997 when they reported that males are more affected by PU, whilst females are more affected by PEOU and Subjective

Norm. On the other hand, age moderates performance and effort expectancy, social influence and facilitating conditions. Experience moderates effort expectancy, social influence and facilitating conditions. Voluntariness of use moderates social influences.[123] Whilst the external variables have been reported to significantly influence adoption and use of technology, it should be noted that the level of significance and type of external variables can change depending on the type of technology and the environment that the technology is implemented in. Some of the most commonly reported external variables that influence adoption and use of technology include: support, enjoyment, implementation process, system quality, user training and user participation in design.[116,125–131]

In 2008, Venkatesh and Bala[132] proposed TAM 3.0 which added the determinants of PEOU (self-efficacy, PBC, anxiety, playfulness, enjoyment and objective usability) to TAM 2.0 to explain between 52% and 67% of the variance in PU across different time periods and models.[132] Venkatesh and Bala[132] further went on to report that the determinants of PU (PEOU, subjective norm, image, job relevance, output quality and results demonstrability) will not influence PEOU and the determinants of PEOU will not influence PU. Thus determinants have no cross over effects and that experience will moderate the relationships between PEOU and PU, anxiety and PEOU and PEOU and behavioural intention. Interestingly, Venkatesh and Bala[132] also reported that subjective norm had a stronger influence on behavioural intention in a mandatory usage environment. Based on the above, figure 1.4 below integrates TRI 2.0 with TAM 3.0 and its supportive theories and determinant variables to conceptualise the Technology Readiness and Adoption Model (TRAM).[133]

In 2016, a systematic review reported that whilst TAM is the most important model to identify factors influencing the adoption of information technologies in the health system, UTAUT model can be used to increase the adoption of health information technology in a healthcare system.[134] Before the Covid-19 pandemic, Asthana et al.[135] reported macro (e.g. budget deficits and staff retention), meso (e.g. geographical funding variation) and micro (e.g. acceptance by healthcare professionals) factors that limit the adoption of e-Health innovation in the NHS. Whilst the pandemic seems to have accelerated improving access to remote consultations in primary care and outpatients, increase in delays to elective care, cancer screening and treatment and mental health have widened existing inequalities in health and care in England and

resulted in further delays in the NHS Long Term Plan.[136] TRAM, as encompasses both arms of technology adoption/use and acceptance/readiness, has the potential to support the NHS Long Term Plan and help the NHS recover by increasing the successful adoption of technology by both healthcare professionals and patients in the management of LTCs. This will support the realisation of the ambition of the NHS based on the 2022 “A plan for digital health and social care” to assist over half a million people to use digital tools to manage their LTCs in their own homes.[137]

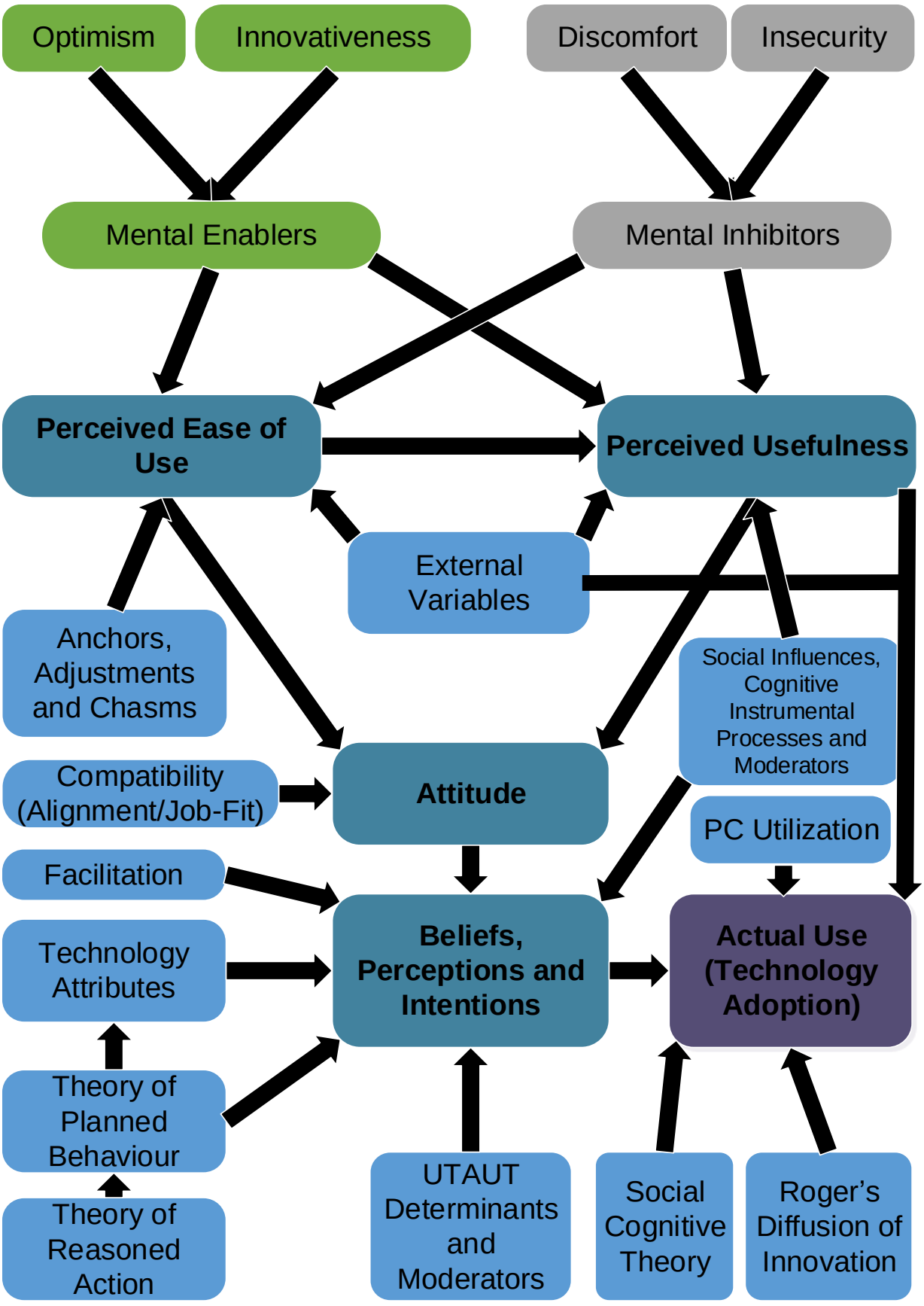

Figure 1. 4:TRAM Model[133]

1.4. Theoretical Domains Framework (TDF)

Whilst TRAM is a technology acceptance and adoption model, The Theoretical Domains Framework (TDF) is a robust theoretical basis for telehealth implementation studies as it provides good coverage of barriers to implementation of telehealth and supports a methodology for progressing from investigation to implementation of telehealth.[138] TDF has undergone a validation exercise with an independent group of behavioural experts to investigate the optimal structure and content of the framework.[139] TDF is an integrated theoretical framework synthesised from 128 theoretical constructs from 33 theories judged most relevant to implementation questions.[138] TDF supports qualitative evidence generation by facilitating identification of the determinants of original behaviours and changed in behaviour within a structured framework containing 14 domains (highlighted in bold below).[138] The TDF domains assist researchers identify and understand the changes in behaviour. Version 2 [138] of the TDF domains are discussed below. It is important to note that the not all the domains below may present in the analysis of original behaviours but may emerge in the analysis of the post intervention reported behaviours and observations e.g. behavioural regulation. TDF has provided guidance on identifying behaviour change techniques [140] and designing intervention strategies.[141]

Knowledge is an awareness of the existence of something including subthemes of knowledge of the condition, procedural knowledge, and scientific rationale. **Skills** is an ability or proficiency acquired through practice including subthemes of skills development, interpersonal skills, and skill assessment. **Social/professional role and identity** is a coherent set of behaviours and displayed personal qualities of an individual in a social or work setting including subthemes of professional role, professional confidence, and leadership. **Beliefs about capabilities** is an acceptance of the truth, reality or validity about an ability, talent, or facility that a person can put to constructive use including perceived competence and beliefs. **Optimism** is the confidence that things will happen for the best or that desired goals will be attained including optimism and pessimism. **Beliefs about consequences** is an acceptance of the truth, reality, or validity about outcomes of a behaviour in each situation including outcome expectancies, characteristics of outcome expectancies and anticipated regret. **Reinforcement** is increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus.

Intentions is a conscious decision to perform a behaviour or a resolve to act in a certain way including the stability of intentions. **Goals** are mental representations of outcomes or end states that an individual wants to achieve including distal and proximal goals, gaol priority, autonomous goals, and implementation intention. **Memory, attention, and decision processes** is the ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives e.g. decision making. **Environmental context and resources** is any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behaviour including environmental stressors, resources, critical incidents, barriers, and facilitators. **Social influences** are those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours. **Emotion** is a complex reaction pattern, involving experiential, behavioural, and physiological elements, by which the individual attempts to deal with a personally significant matter or event. This can be an induced by a positive or negative affect. **Behavioural regulation** is anything aimed at managing or changing objectively observed or measured actions including self-monitoring and action planning.[138]

TDF was identified as the most suitable framework for Chapter 2 (The feasibility of using digital health in a nursing care home for dementia residents' healthcare team perceptions and preliminary outcomes) as it can identify cognitive, affective, social, and environmental influences on health professional behaviour related to implementation of evidence-based recommendations and has been cited in over 800 peer-review publications.[142] TDF has been used to identifying influences on behaviours in dementia diagnosis and management[142] and has been used in systematic intervention design with HCPs.[143,144] HCPs have reported increased self-confidence in undertaking projects, providing a wide perspective, and providing means of understanding implementation problems and potential solutions when using TDF.[138]

1.5. Thesis Rationale

TH has been trialled in various healthcare settings and conditions and systematic reviews have reported both benefits and challenges in adopting TH in clinical practice. The NHS has identified digital solutions as a crucial tool to overcome healthcare gaps. Mobile technology has been highly adopted in the personal lives of HCPs and patients and its potential to add value to clinical practice was a gap that was identified in the literature. These factors create the ideal platform to test the feasibility of mobile technology in healthcare.

The researcher is an oncology clinical trial pharmacist who has an interest in the application of digital healthcare to improve both the healthcare professional and patient journey experience and patient health outcomes. The researcher has previously conducted research in the potential of mobile technology to increase smoking cessation. Kingston University has a long-standing research collaboration with Croydon NHS Trust that previously focused on telehealth and has evaluated the feasibility of telehealth solutions in community e.g. a WELCOME (EU grant) funded wearable technology for COPD telemonitoring in the community.[44,70,145] A decision was made to expand this collaboration with the appointment of the author who was also jointly supervised as a PhD researcher to evaluate the use of digital technology and telehealth in other healthcare environments e.g. care homes and in other areas of interest to the trust. The collaborative work was jointly supported by an Innovate UK funded grant to investigate simple telecommunications to prevent readmission, so both studies were to improve care with focus on reduction on readmission, whether recurrent or for those in care homes. However, it seemed logical to also check whether telehealth can support screening of disease in another vulnerable population; the paediatric population. The three arms were selected based on Croydon's NHS Trust including: *Improving Health and Reducing Inequalities* driving the research in a care home for residents with dementia, *High Quality Care* driving the remote evaluation of heart sounds in paediatric patients to detect cardiac murmurs and *Integrated Care Systems* driving the prevention of the re-admission of patients to hospital within 30 days post-discharge.[146]

Therefore, this thesis aimed to evaluate the feasibility of digital technology in healthcare, using Croydon NHS Trust and borough as a locality. Croydon NHS Trust prioritises both national and local research initiatives annually for which resources are allocated accordingly.

1.6. Research Design

The overall research design for this thesis is illustrated in Table 1.1. A mixed-method research approach was used in this study to allow integration of both qualitative and quantitative techniques. Morse and Niehaus[147] defined mixed method design as "the use of two or more research methods in a single study, when one or more of these methods is not complete in itself". Greene et al.[148] identified the five drivers for mixed-method evaluations as: triangulation, complementarity, development, initiation, and expansion. This is of great value in complex research studies e.g. social sciences and healthcare as drivers of outcomes are usually multifactorial due to the nature of the science.[147,148] This approach was selected to maximise data collection during the study, confirm consistency of results collected and allow for a comparative analysis of results collected using various techniques.

Table 1. 1 Research Design Overview

Evaluation of the feasibility of using digital solutions to support the provision of healthcare in the NHS						
Scope	Telehealth System in Care Home Residents with Dementia		Preventing Re-Admission of Patients within 30 days of Discharge	Remote Screening of Congenital Murmurs		
Objective	To measure the response frequency of general practitioner visits, non-elective hospital ED and inpatient visits and antibiotic prescriptions in the care home before and after the implementation of a structured monitoring telehealth system	To explore multidisciplinary HCPs' awareness and experiences of telehealth and their perceptions of it pre and post implementation in the care home	To evaluate patients' satisfaction with the OPTIMAL discharge intervention and its effect on their discharge experience	To acquire and compile a database of heart sounds from paediatric patients using an electronic stethoscope which would then be used to develop and apply methods to investigate and analyse heart sounds of paediatric patients and compare the waveforms of heart sounds from infants where murmurs were detected to waveforms of heart sounds from infants with no discernible murmur	To investigate the ability of clinicians to retrospectively identify heart sounds in both local general and remote specialist hospitals	To evaluate the usability of an electronic stethoscope and associated software amongst clinicians with different levels of experience
Methodology	Quantitative	Qualitative	Quantitative	Quantitative and Qualitative		
Data Source or Collection Tool	Telehealth System and Patient Notes	Semi-Structured Interviews	OPTIMAL Database	Cardiac Recordings from participants. Structured and Semi-structured Surveys and Interviews		
Outcome	Telehealth improved clinical outcomes	Barriers and facilitators of telehealth implementation and use identified	Prevention of hospital re-admission	Database of heart sounds developed and waveforms created to differentiate between normal and congenital murmurs	Heart sounds accurately screened locally and remotely to identify congenital murmurs	Positive Usability Scores
Application	Recommendation for implementation of digital healthcare solutions in the NHS					

1.6.1. Study Setting

Croydon has the 2nd highest (n=384,837, 2019) population in London and has just over half (51.7%) of the population classified as Black, Asian and minority ethnic (BAME) and over 100 languages spoken.[149] Croydon Health Services NHS Trust provides integrated NHS services to care for people at home, in schools, and health clinics across the borough as well as at Croydon University Hospital (CUH) and Purley War Memorial Hospital.[150] CUH provides more than 100 specialist services and is home to the borough's only Emergency Department and 24/7 maternity services.[150]

In 2018, CUH was the top (873 to 2544, 191%) acute trust in recruiting research participants.[151] Although CUH was not always the site of research in Croydon for all the studies conducted in this thesis e.g. Albany Lodge (AL) is a care home in Croydon, the CUH Research and Development department was centrally co-ordinating all studies. Croydon is an ideal setting to perform studies in a diverse population that are supported by the CUH Research and Development department.

1.7. Thesis Layout

This thesis consists of five chapters. All evaluations presented are based on Croydon NHS Trust and public health priorities, as outlined above.

Chapter One introduces the study environment (NHS) and the legislative and theoretical frameworks that influenced the study design. Theoretical models include technology adoption models and analytical frameworks identified to analyse data collected via a mixed method approach. A detailed literature review of technology enabled care in the treatment of long-term conditions is presented to support the following chapters.

Chapter Two evaluated a remote monitoring THS in a care home with residents with dementia. Equivalent periods of both pre and post system implementation were analysed to identify potential improvements in clinical outcomes for residents. HCPs were also interviewed using a semi structured questionnaire before system implementation and at the end of the study to identify perceptions and any changes towards TH. This study also identified challenges in TH implementation. The author was responsible for the evaluation conception, design, analysis and reporting. The inclusion criteria for patients and the care home of choice were decided by the telehealth nurse lead in Croydon, based on local priorities. All other parts of the study were devised by the author.

Chapter Three evaluated the potential for OPTIMAL THS to prevent early readmission of patients to hospital. TH prompted interventions were actioned to ensure that patients received the required community healthcare post discharge. Patient interventions were calculated, and frequencies of early re-readmissions were analysed. Patients' satisfaction of the system was evaluated using a survey. The OPTIMAL RCT protocol was submitted as part of the funding bid to Innovate UK.[152] The author was responsible for the conception of the evaluation work package, its design, data collection, analysis and reporting as presented in this thesis.

Chapter Four is titled The Physician's Ear. Heart sounds of congenital murmurs and heart sounds without a murmur were recorded in a clinic using an electronic stethoscope. Recordings were transferred to Matlab® to depict waveforms with disenable characteristics to identify congenital murmurs. Recordings were evaluated by HCPs using a survey both locally and at a remote NHS site to determine the

feasibility of remote congenital cardiac screening. The usability of the system and the stethoscope was also evaluated by HCPs. The study conception, design, evaluation and reporting were completed by the author. This required training on heart sounds acquisition. The translation of heart sounds into sound waves using MATLAB (The MathWorks Inc., USA) was conducted by one of the supervisors.

Chapter Five discusses the feasibility of using digital technology in the NHS considering the results from the mixed method study approach. The results are critically analysed in reflection of the current environment e.g. the pandemic and limitation of the studies are reported alongside limitations and opportunities for further research.

Chapter 2: The feasibility of using telehealth in a nursing care home for dementia residents: Healthcare team perceptions and clinical outcomes

2.1. Background

2.1.1. Definition, Classification, Subtypes and Severity of Dementia

The WHO[153] defines dementia as a syndrome due to a disease of the brain, usually of a chronic or progressive nature, in which there is disturbance of multiple higher cortical functions, including, memory, thinking, orientation, comprehension, calculation, learning capacity, language, and judgement.[153] The American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) has reclassified "*dementia"* as neurocognitive disorder (NCD).[154] The NCDs progress into syndromes of major NCD, mild NCD, and their etiological subtypes of which dementia is mainly classified as a major NCD.[154] According to WHO, the subtypes of dementia include: Alzheimer's disease (AD), vascular dementia (VaD), mixed dementia (MD), Lewy body dementia (LBD), frontotemporal dementia (FTD), Parkinson's disease dementia (PDD) and others.[155] The severity of dementia has been reported in studies as mild, moderate and severe.[156]

2.1.2. Prevalence of Dementia

The accelerating growth rates of dementia both globally and locally over the last few years requires immediate attention as the WHO does not regard dementia as a normal part of ageing.[153] In 2013, a systematic review and meta-analysis estimated that the global prevalence of dementia in 2010 was 35.6 million and is expected to almost double every 20 years to 65.7 million in 2030 and 115.4 million in 2050. This review reported that globally there are 7.7 million new cases of dementia each year, implying an occurrence of a new case of dementia in the world every four seconds.[157] Interestingly, the World Alzheimer's Report of 2018 reported that 50 million people worldwide were living with dementia in 2015 and this amount will double every 20 years, reaching 82 million in 2030 and 152 million in 2050. [158,159]

In 2007, MacDonald et al.[160] estimated 74.0% (95%CI 62–83) for the prevalence of dementia of which two-thirds would be moderate or severe and one-third would be mild. They highlighted the growing prevalence of dementia and the corresponding increase in demand for long-term care services resulting in a shortage of resources and a crisis in the provision of care as healthcare systems are significantly impacted highlighting the

need for increased investment in research and development to find more effective treatments for dementia.

The UK population is ageing due to an increase in life expectancy.[161] In 2014, Dementia UK reported that the UK prevalence of dementia for people over 65 years old was 7.1% representing one in 79 (1.3%) of the entire UK population and 1 in 14 of the population aged 65 years and over.[155] This report estimated that there will be 850,000 people with dementia in the UK in 2015, over 1 million by 2025 and over 2 million by 2051 at its current growth rate.[155] This report also noted that there are over 40,000 people with early-onset dementia (under the age of 65 years) in the UK.[155] Stewart et al.[162] in 2014, surveyed 15 randomly selected South East London care homes and reported an overall prevalence of dementia of 75.1% consisting of 55.8% in residential homes, 91.0% in residential elderly mentally infirm care and 77.0% in nursing homes.

The association between ageing and pre-dementia conditions can be seen more commonly in women as women represent two thirds majority of dementia sufferers in the UK due to their longer life expectancy than in men.[163,164] As part of the NHS Quality Outcomes Framework (QOF), NHS Digital has been reporting dementia prevalence rates as confirmed and reported by general practitioners (GPs) in England. In May 2019, NHS Digital reported a dementia prevalence rate of 0.79% in England (470,234 of 59,626,147 GP registered patients).[165] NHS Digital has also reported that 69.9% (2366 of an estimated 3383 patients with dementia) of patients over 65 years in Croydon were diagnosed with dementia.[165] A community study in London has reported the following frequencies of dementia subtypes: AD=41%, VaD=32%, LBD=8%, PDD=3%, and FTD=3%.[166] LBD develops in one third of older people with Parkinson's disease (PD) after 10 years.[167] FTD has a concerning incidence which is equal to or greater than AD in patients younger than 60 years.[168–170] Using data from 2007, Dementia UK reported the following frequency of severities of dementia in over 65 years old: mild dementia (55.4%), moderate dementia (32.1%) and severe dementia (12.1%).[155] The level of severity of dementia reported during March 2015 was 54.9% mild, 32.6% moderate and 12.5% severe with a dementia diagnosis rate of 51.8%.[171]

The London School of Economics and Political Science commissioned by the Alzheimer's Society reported the following projections of older people with dementia and costs of dementia care in the United Kingdom from 2019 to 2040. It estimated that

900,000 people had dementia in 2019 projected a rise to 1.6 million people by 2040. In 2019, the report estimated that 209,600 people (1 every 3 minutes) will develop dementia and that 70% of care homes residents have dementia or severe memory problems. Interestingly, this report estimated that greater than 42,000 people under 65 have young-onset dementia in the UK and that more than 25,000 people from Black, Asian and minority ethnic groups in the UK are affected by dementia.[172] Alzheimer's Research UK has created a Dementia Statistics Hub dashboard with currently UK statistics about dementia including: number of people with dementia (944,000 in 2022), incidence of people born that will develop dementia in their lifetime (1 in 3) and estimated UK cost of dementia (£25 billion).[173] Alternatively, the Dementia Profile developed by the Office for Health Improvement and Disparities consists of six data indicator domains: Prevalence, Preventing well, Diagnosing well, Living well, Supporting well and Dying well.[174]

Several factors such as comorbidities, age, gender, place of residence and delirium have been reported to impact the prevalence of dementia.[163,164,175–179] Poorer outcomes can be attributed to the higher prevalence of comorbid conditions e.g. it has been reported that 61% of care home residents with AD have three or more comorbid conditions.[178,179] There is also a direct relationship between the severity of dementia and the number of comorbid conditions.[180] This results in a growing financial impact as the care requirements increase in complexity with associated co-morbidities.[180]

2.1.3. Diagnosis of Dementia

The diagnostic criteria for major NCDs includes evidence of significant cognitive decline from a previous level of performance in one or more cognitive domains (complex attention, executive function, learning and memory, language, perceptual-motor, or social cognition).[154] This is based on the concern of the individual, a knowledgeable informant, or the clinician that there has been a significant decline in cognitive function. It can also be based on a substantial impairment in cognitive performance, preferably documented by standardized neuropsychological testing or, in its absence, another quantified clinical assessment. The cognitive deficits interfere with independence in everyday activities (at a minimum, requiring assistance with complex instrumental activities of daily living such as paying bills or managing medications) and they do not occur exclusively in the context of delirium.[154]

Although dementia is mainly classified as a major NCD, it can also manifest itself as a mild NCD.[154] The diagnostic criteria for mild NCD are identical to those of a major NCD but is based on modest cognitive decline from a previous level of performance as raised by concerns of family members or clinicians or through a clinical assessment.[154] The cognitive deficits do not interfere with capacity for independence in everyday activities (complex instrumental activities of daily living such as paying bills or managing medications are preserved, but greater effort, compensatory strategies, or accommodation may be required).[154] Furthermore, the cognitive deficits do not occur exclusively in the context of delirium and are not better explained by another mental disorder (e.g. major depressive disorder, schizophrenia).[154]

The Scottish Intercollegiate Guidelines Network (SIGN) guideline 86: *"Management of patients with dementia*" warns that a patient with dementia may not be able to give a fully accurate history and that a relative or carer should also be interviewed.[181] Whilst the DSM-5 has a reported good diagnostic criteria for AD with an accuracy sensitivity of up to 80%, none of the diagnostic criteria are accurate in mixed subtypes of dementia.[181–183] However, studies have shown that the Hachinski Ischaemic Score can be used to differentiate the diagnosis of AD from VaD.[184] Cognitive testing using a Mini-Mental State Examination (MMSE) is recommended after taking a patient history and applying DSM criteria as recommended by SIGN guideline 86 and National Institute for Health and Care Excellence (NICE) guideline 42: "Dementia: supporting people with dementia and their carers in health and social care".[181,185] The maximum MMSE score

is 30 points and thus the severity of dementia can be classified as follows: mild dementia = 20 to 24 points; moderate dementia = 13 to 20 points and severe dementia ≤ 12 points.[186] Reported limitations of MMSE include ceiling effects when used for poorly educated people and floor effects for those with higher education.[187] The MMSE has also been reported to be more suitable for measuring the cognitive deficits in AD and may be less sensitive to those with VaD or FTD. [188,189]

Unfortunately, some studies have reported that formal cognitive assessment may not be conducted in as many as 30% to 50% of cases.[190,191] Therefore, other scales have been used to monitor cognitive outcomes.[221-225] Whilst the prevalence of reversible dementia has been reported to be low (0.6%), older patients should be screened for co-morbid and co-existing medical conditions e.g. blood tests can identify hypothyroidism and vitamin B12 deficiency as treatment of some of these conditions could reverse dementia in these cases.[181,192,193] HCPs need to be aware of conditions associated with dementia e.g. a systematic review has reported that patients who are depressed and have cognitive impairment are highly likely to be diagnosed with dementia and that 12% of patients with dementia were depressed whilst a cohort study found that depression is a prodrome of dementia. [182,194]

Imaging e.g., computed tomography (CT), magnetic resonance imaging (MRI), single photon emission-controlled tomography (SPECT) and positron emission tomography (PET) should be used to aid in the diagnosis of dementia for all patients. A systematic review of seven studies including 50 patients has reported that clinical predictive imaging guidance has poor sensitivity and specificity and resulted in a 5% prevalence of patients with potentially reversible causes of dementia being missed.[195] The use of MRI to measure the hippocampal volume has been reported to support the early diagnosis of AD with a sensitivity of 95% and a specificity of 92%, and even though MRI has been reported to be superior to a PET and SPECT, it has not been proven to be as effective as the neuropsychological methods e.g. a formal cognitive assessment.[196] Thus, the combination of neuropsychology and imaging results has been reported to increase diagnostic accuracy (from 80 to 100% predictive accuracy, sensitivity from 53 to 80% and specificity from 67 to 99%) and should be used in the diagnosis of dementia as it has been reported to provide a pattern of cognitive impairment that can predict progression to dementia.[197,198]

The importance of the accurate diagnosis of subtypes of dementia has increased due to the licensing requirement of medication for AD.[181] Responses and side effects of treatment in patients with MD can vary from those with a specific subtype.[181] There are serious side effects of antipsychotics in people with LBD and it is estimated that 30-50% of LBD patients taking antipsychotics can experience neuroleptic sensitivity reactions including sedation, increased confusion, rigidity, and immobility that may occur after taking a neuroleptic medication.[181] This can also occur in patients with MD subtypes.[199,200]

2.1.4. Behavioural and Psychological Symptoms of Dementia and their management

In 1996, the International Psychiatric Association introduced the term 'Behavioural and Psychological Symptoms of Dementia' (BPSD) and measured symptoms using several inventories e.g. the NPI and Frontal Behavioural Inventory (FBI).(Appendix 15) [201–205] A review of 62 studies reported that common BPSD included psychosis, delusions and hallucinations, hyperactivity, irritability and aggression and affective symptoms including depression, anxiety and euphoria.[206] Ballard[207] reported in a case control study consisting of 124 patients meeting the DSM-3 dementia criteria that there was a prevalence of major (25.0%) and minor (27.4%) depression in patients with dementia and that major depression had a significantly increased frequency and severity in patients with VaD than patients with AD (Mean scores 12.64 vs. 9.16, Mann-Whitney U-test, $z = 2.30$ $P = 0.02$). In comparison in Greece, the Hellenic Longitudinal Investigation in Aging and Diet study (HELIAD, 1867 older adults >64 years old; 41.3% men) reported a prevalence of 17.2% of depression in patients with dementia.[208] Without pharmacological and/or non-pharmacological interventions, BPSD can cause significant carer stress and burden to care home HCPs resulting in unplanned long hospital admissions which potentiate delirium and BPSD in dementia care home residents due to long relocation to unfamiliar environments.[209]

In the UK, risperidone is the only licensed pharmacological intervention that is indicated for the short-term treatment (up to 6 weeks) of persistent aggression in patients with moderate to severe AD unresponsive to non-pharmacological approaches and when there is a risk of harm to self or others.[210] However, the risk of increased morbidity and

mortality linked to the use of antipsychotic drugs in patients with dementia has been reported by the Medicines and Healthcare products Regulatory Agency (MHRA) since 2004 and thus non-pharmacological interventions are recommended as an initial intervention.[210–214] Despite the previously outlined risk, a 16% (1620 of 10199 patients) UK prevalence of antipsychotics prescribing for BPSD has been reported that included: quetiapine (36%), risperidone (26%), haloperidol (10%), olanzapine (9%) and amisulpride (9%).[215]

Both a Cochrane Review in 2013 and the NICE in 2018 has recommended the safe withdrawal of chronic antipsychotic usage in older people with AD neuropsychiatric symptoms (NPS) as routine practice except in patients with severe baseline NPS.[216,217] Best practice guidance in care homes has also highlighted the importance of a prescription monitoring program to control the prescribing and evaluate the current need for antipsychotics for each resident.[218,219] NHS Digital has reported a decrease in antipsychotic prescribing in their National Dementia and Antipsychotic Prescribing Audit from 17.05% in 2006 to 6.8% in 2011.[164] This work needs to be ongoing as the latest audit in May 2019 reported that 9.31% (43772 of 470,234) patients had received a prescription for antipsychotic medication within the last 6 weeks.[165,220] Of even greater concern is that a systematic review has reported a higher prevalence (42.1% to 74.6%) in audits of antipsychotic prescribing for residents with dementia in nursing home.[221–224]

NPS of residents in care homes with dementia has also been improved using both person-centred care and nonpharmacological interventions.[225–230] The Well-Being and Health for People with Dementia (WHELD) Program, was a randomised controlled two-arm cluster single blind trial that was conducted over nine months across 80 care homes in the United Kingdom.[231,232] The WHELD intervention included person-centred training that provided care home HCPs with updated knowledge regarding person-centred activities and interactions, and the optimal use and monitoring of psychotropic medications for people with dementia in care homes delivered by staff champions.[232] As part of WHELD, a multi-factorial Cluster Randomised Controlled Trial (CRCT) was conducted by Ballard et. al [231] in residents with dementia in 16 U.K. care homes over 9 months. All homes received person-centred care training however, only 8 homes were randomly assigned to either antipsychotic reviews or social interaction interventions or to exercise interventions. This CRCT reported that antipsychotic medication reviews significantly reduced antipsychotic medication use by 50% (odds ratio 0.17, 95%

confidence interval [CI] 0.05 to 0.60) and that antipsychotic medication reviews plus the social interaction intervention significantly reduced mortality (odds ratio 0.26, 95% CI 0.13 to 0.51) compared with the group receiving neither. The group receiving antipsychotic medication reviews but not the social interaction showed significantly worse outcome in NPS compared with the group receiving neither (score difference +7.37, 95% CI 1.53 to 13.22). NPS were significantly improved by concurrent delivery of the social interaction (−0.44, CI −4.39 to 3.52) and exercise intervention (−3.59, 95% CI −7.08 to −0.09). Thus, this CRCT concluded that antipsychotic medication reviews can reduce their usage but must be supported by non-pharmacological interventions e.g. social interaction and exercise.

As part of the 9-month CRCT, Ballard et al.[233] randomly allocated 847 residents with dementia living in 69 UK care homes and compared the WHELD program to treatment as usual (TAU).[233] A total of 553 residents were included in the CRCT. The results showed that the WHELD program caused a statistically significantly improvement in the QoL ($p= 0.0042$) of residents and reduced agitation ($p= 0.0076$) and overall NPS ($p< 0.001$).[233] Positive care interactions improved as measured by Quality of Interactions Scale (QUIS) ($p= 0.03$) however, antipsychotic drug use was at a low stable level in both treatment groups and thus the WHELD program did not reduce their use.[233] Ballard et al.[233] reported that the mean baseline costs was higher for TAU than the WHELD intervention for both hospital (£407 vs. £387) and primary care (£98 vs. £96) respectively.[233] This result was also true at 9 months as Ballard et al.[233] reported that the mean cost of TAU was higher than the WHELD intervention for hospital care (£269 vs. £26), primary care (£1020 vs. £700) and emergency care (£85 vs £49) respectively with the greatest benefits of the WHELD programme reported in people with moderately severe dementia.[233] Ballard et al.[233] concluded that the WHELD programme can improve the QoL, reduce agitation and NPS and reduce the cost of care.[233]

Pharmaceutical Care is the pharmacist's contribution to the care of individuals in order to optimize medicines use and improve health outcomes.[234] The most robust evidence to reduce inappropriate psychoactive prescribing used an adapted model of Pharmaceutical Care implemented by specialist pharmacists who screened nursing home residents' (65 years and older) prescriptions in Northern Ireland using an algorithm during a cluster randomized controlled trial (n=334; 173 intervention, 161 control) over 12 months.[235] This study reported that the residents in the intervention

home (25/128, 19.5%) took fewer inappropriate psychoactive medication than the residents in the control home (62/124, 50.0%) yielding an odds ratio of 0.26 (95% confidence interval=0.14–0.49) thus concurring with the findings of Ballard et al.[231,235] regarding the value of antipsychotic medication reviews in reducing the burden of inappropriate antipsychotic prescribing in dementia patients.

In 2022, Webster et al.[236] conducted a secondary analysis of participants in 97 English care homes and reported a baseline prevalence of clinically significant sleep disturbance of 13.7% (200/1460) and 31.3% (457/1462) at least once over 16 months with a one-year incidence of 25.2% (252 cases per 1000 person-years). At baseline, residents with sleep disturbance had lower quality of life (mean difference –4.84; 95% confidence interval [CI] –6.53 to –3.16) and were more frequently prescribed sleep medications (odds ratio 1.75; CI 1.17 to 2.61) than other residents. Therefore, this study reported that approximately one-third of care home residents with dementia have or develop sleep disturbances over 1 year that is associated with lower quality of life and an increased prescription rate of sedatives with potential negative outcomes highlighting the importance to develop effective treatments and optimise treatments used.[236]

2.1.5. Management of Dementia

Dementia symptomatic treatments can be non-pharmacological or pharmacological. Non-pharmacological interventions include behaviour management, caregiver programmes, cognitive stimulation, environmental design, music therapy and recreational activities.[181] A systematic review of 18 studies reported that the most beneficial non-pharmacological interventions were music therapy, interventions targeting pain, person-centred care approaches and education for family caregivers.[237]

Pharmacological interventions mainly include: cholinesterase inhibitors e.g. donepezil, rivastigmine and galantamine; glutamate receptor antagonists e.g. memantine and blood regulators/oxygen free radical scavengers e.g. gingko biloba whilst symptomatic supportive pharmacological interventions include antidepressants, antipsychotics, anticonvulsants, melatonin and benzodiazepines.[181,238] A systematic review and meta-analysis of 88 trials evaluating the effects of donepezil, rivastigmine and galantamine, and memantine on cognitive function in dementia reported that these medication can improve the MMSE score by 1 point at 3, 6, and 12 months after treatment initiation.[239]

Whilst this may be a small value as studies have reported that annual rate of MMSE decline is 4-5 points, the clinical value contribution of the medication is an approximate 3-month delay in cognitive decline and thus could have a significant impact in delaying and reducing the rate and cost associated with care home and hospital admissions as these have been linked to cognitive MMSE levels.[240,241] However, this systematic review and meta-analysis also reported that cholinesterase inhibitors were more effective on improving the MMSE score in subtypes of dementia that have an increased cholinergic deficit e.g. PD and LBD (1.99 MMSE points at 3 months and 2.11 points at 6 months) than other subtypes e.g. AD and VaD (0.97 MMSE points at 3 months and 0.91 points at 6 months) as previously reported in other studies.[239,242,243] Gingko biloba extract, EGb 761® (24 mg of total flavone glycosides and 6 mg of ginkgolides per 100 mg) has been reported in a 2009 Cochrane review that included 36 trials and 4441 participants with dementia of any severity or cognitive impairment with an average duration of treatment of 12 weeks (3 to 52 weeks) to have no difference from placebo in terms of benefits and adverse events.[244] In 2017, however, an overview of 12 systematic reviews with meta-analyses (138 trials, 25186 participants) reported that *gingko biloba* offers clinical benefits in cognition, global change and function over placebo at doses greater than 200 mg/day taken for greater than 5 months and is safe for human consumption.[245] Interestingly, in 2018, a meta-analysis of four RCTs including 796 patients taking 240mg EGb 761® and 802 patients taking placebo for 22 to 24 weeks reported statistically significantly reducing caregiver distress scores ($p<0.001$) and statistically significantly improving BPSD ($p<0.001$) symptoms of apathy, sleep disturbances, depression, anxiety and irritability but not psychotic behaviours e.g. delusions, hallucinations, and euphoria.[246]

2.1.6. Co-Morbidities and hospital admissions associated with Dementia

In 2014, a systematic review has reported that the prevalence of comorbid conditions in people with dementia is high and that people with dementia have poorer access to services.[179] A cross sectional study consisting of 72,815 patients who are older than 64 years used three analytical methods, that is, analysis of prevalence data, multiple regression and factor analysis to analyse the electronic health records of patients with dementia.[247] Whilst the analysis of prevalence data identified that the two most frequent comorbidities both for men and women with dementia were hypertension and diabetes,

logistic regression and factor analysis demonstrated that the comorbidities significantly associated with dementia were PD, congestive heart failure, CVD, anaemia, cardiac arrhythmia, chronic skin ulcers, osteoporosis, thyroid disease, retinal disorders, prostatic hypertrophy, insomnia, anxiety and neurosis.[247] Another study has reported that four of the most common comorbidities of care home residents with dementia that are admitted to hospital are preventable conditions (falls, broken/fractured hip/s or hip/s replacement, urinary and respiratory tract infection).[248]

A study reported that 30% of older people in hospital have dementia and that hospital admissions for avoidable conditions are 30% higher for people with dementia.[175,176] It has been reported that 42% of unplanned admissions of care home residents over the age of 70 years to an acute hospital, have dementia.[249] Care home residents with dementia are over three times more likely to die during their first hospital admission for an acute medical condition than those without dementia.[249] Furthermore, care home residents with dementia are unable to communicate their deterioration in health resulting in an increased severity in their medical condition with longer hospital admissions and poorer outcomes.[176,177] As outlined previously, *dementia* is classified as NCD.[154] NCDs begin with delirium, followed by the syndromes of major and mild NCDs. Delirium is diagnosed when there is disturbance in attention, awareness, or cognition from baseline due to a direct physiological consequence of another medical condition, medication exposure or withdrawal, so it has a clear aetiology.[154] A study has reported that the type of delirium presented by a patient on admission can influence the duration of stay in hospital.[250] Patients with hypoactive delirium are more ill on admission and have had longer durations of hospital admission whereas patients with hyperactive delirium were reported to most likely to fall whilst in hospital.[250] O'Keeffe and Lavan investigated the clinical significance of delirium subtypes in 94 older people over 225 admissions and reported that significant differences existed between the four subtypes of delirium (hyperactive delirium, hypoactive delirium, mixed hypoactive–hyperactive psychomotor pattern and no psychomotor disturbance) in illness severity ($p<0.05$), length of hospital stay ($p<0.005$) and frequency of falls ($p<0.05$).[250] Wahlund and Björlin conducted a study over 18 months whilst treating suspected delirium (n=637) and reported that infectious diseases e.g. urinary tract infections (UTI); a co-morbidity of dementia, were the main cause (67%) of delirium.[251]

In 2019, Shepard et al.[252] published a systematic review and meta-analysis to evaluate hospitalisation rates and clinical predictors of hospitalisation in people with dementia.[252] This paper included 34 studies (17 from the USA, 15 from Europe, and 2 from Asia) and 277,432 people with dementia and reported that after adjusting for age, sex, and physical comorbidity, the pooled relative risk of hospitalisation for people with dementia compared to those without was 1.42 (95% CI: 1.21-1.66) and that high quality studies reported hospitalisation rates of people with dementia of between 0.37 to 1.26/person/year.[252] Whilst dementia severity alone was not associated with admissions, there was moderately strong evidence that admissions are associated with multimorbidity, polypharmacy and lower functional ability and strong evidence that admissions are associated with older age.[252] This systematic review and meta-analysis thus concluded that people with dementia are more frequently admitted to hospital than those without and that future interventions should be focused on modifiable risk factors e.g. polypharmacy and functional ability, in high-risk populations.[252]

2.1.7. Admissions due to Inappropriate Prescribing and Falls

Onatade et al.[253] reported potentially inappropriate medication (PIM) prevalence rates in the UK at 26.7% (95% CI: 20.5 - 32.9; 52 patients, 74 PIMs) among patients on hospital admission.[253] This prevalence was doubled in patients receiving more than ten medications as compared with those taking fewer (odds ratio 2.3 [95% CI: 1.2 - 4.4]; p = 0.01).[253] However, Onatade et al.[253] also reported a hospital discharge PIM prevalence of 22.6% (95% CI: 16.7 - 28.5; 44 patients, 51 PIMs), with a significant reduction of PIMs on discharge (p= 0.005).[253] The most commonly reported PIM categories on admission were: central nervous system and psychotropic drugs, drugs adversely affecting patients at risk of falls and drugs acting on the urogenital system.[253] Another study reported that inappropriate medication use in the elderly occurs frequently and can be harmful and proposed the use of two screening tools to assess potentially inappropriate prescribing in the elderly through structured clinical medication reviews to care home residents including: a Screening Tool of Older People's Prescriptions (STOPP) that contains 65 clinically significant criteria for potentially inappropriate prescribing in older people and a Screening Tool to Alert to Right Treatment (START) that contains 22 evidence-based prescribing indicators for commonly encountered diseases in older people.[254] Tanna et al.[255] recommended a

need for more research on the impact of the STOPP-START interventions on both the rates of falls and risk of falls in the elderly.[255]

In July 2014, the All Wales Medicines Strategy Group published: “Polypharmacy: Guidance for Prescribing”.[256] This guidance identified that the side effects of certain medication groups e.g. centrally acting medication with sedating effects, make them “High Risk” and “Known to cause falls” in the elderly and offered recommendations to minimise this risk.[256] This guidance, and others have also identified an “Anticholinergic Cognitive Burden Scale” [Anticholinergic Risk Scale(ARS)] that classifies medication groups using the following scale: Score of 1 (Evidence from in vitro data that chemical entity has antagonist activity at muscarinic receptor), Score of 2 (Evidence from literature, prescriber’s information, or expert opinion of clinical anticholinergic effect) and a Score of 3 (Evidence from literature, expert opinion, or the prescribers information that medication may cause delirium).[257]

High risk medication, medication that cause falls and medication with a high ARS needs to be reviewed and their benefits weighted against the risk of usage.[256] The Co-Morbidity Polypharmacy Score (CPS) evaluates severity of the synergistic impact of pre-injury medication and known co-morbidities and classifies the severity of the synergy using the following points scale: mild (0-7), moderate (8-14), severe (15-21) and morbid (≥ 22).[258] Older trauma patients with a CPS > 15 have a greater risk for mortality, complications, and longer durations of hospital admissions.[258] There also exist a proportional relationship between higher CPS scores and 30 day hospital re-admissions.[258] In 2017, Tolentino et al.[259] reported that CPS is a reasonable platform for patient risk stratification as it is independently associated with readmissions and mortality across all age groups of patients admitted to hospital.[259]

A Cochrane review of multi-disciplinary interventions that aim to optimise prescribing for older people in care homes has reported that such interventions may lead to fewer days in hospital, a reduced decline in health-related QoL, the internal and resolution of medication-related problems and potential improved medication appropriateness through effective medicine reviews.[260] The Royal Pharmaceutical Society (RPS) has also supported the role of pharmacist to include the improvement of medication usage in care homes.[261] Zermansky et al.[262] has reported that pharmacist driven medication reviews have led to a reduction in falls in care homes.[262] Medication reviews should

focus on reducing the use of psychotropic drugs by residents with dementia in care homes to ensure patient safety.[254] Another cause of falls is low calcium and Vitamin D levels and thus prevention has been reported using calcium and vitamin D supplementation.[263]

2.1.8. End of Life Care and National Gold Standards Framework

Although care homes have the responsibility of caring for residents nearing the end of their lives, there is limited training and resources to support care home staff. The use of monthly action learning with HCPs e.g. nurses and carers whilst implementing an integrated care plan (ICP) during the last days of care home residents lives has been reported in previous studies to improve critical reflection on issues of concern for care home HCPs.[264,265] A 2008 National Audit report estimated that 40-50% of hospital deaths could have been avoided by enabling residents to live and die where they choose to with better community care and trained staff.[266] Based on this audit, the DH recommended that organisations e.g. care homes, prioritise improving end of life care (EOLC) by adopting the National Gold Standards Framework Care Homes (GSFCH).[267,268] The GSFCH recommended a facilitator visiting each care home every 10–14 days to support implementing different systems and role modelling good palliative care during EOLC.[264,265] The GSFCH framework included a training and reaccreditation programme in EOLC and has since been implemented in about 3000 care homes and in over 40 project areas of Clinical Commissioning Groups (CCG) resulting in a reduction of 50% of hospital deaths, 50% of ED admissions and reduced length of stay in hospital and thus has improved cost effectiveness due to reduced avoidable hospitalisation through coordination and collaboration between HCPs.[269,270]

The largest CRCT in the implementation of the GSFCH by nursing managers in the UK compared the effect of high facilitation with the addition of action learning (61 residents; quartiles 34–83) to high facilitation alone (48 residents; quartiles 28–59) and to an observational group (54 residents; quartiles 37–75).[271] The primary outcome of this CRCT was the place of death of the resident whilst secondary outcomes included: EOLC including the undertaking of advance care planning (ACP), having a cardiopulmonary resuscitation decision and using EOLC plan documentation, that is an ICP.[271] The arm with higher facilitation and action learning showed a statistically different effect in the use of ICP ($p= 0.036$) due to the specific support provided to nurse managers through action learning and the open discussions about death and dying.[271] Some issues that nurse managers reported included: complex residents and challenging families, relationships with GPs and issues to do with ‘do not attempt cardiopulmonary resuscitation’, inappropriate hospital admissions/poor communication, time pressures, workload, shortage of staff and managerial pressures and

organisational issues. An important lesson from the CRCT was that funding needs to be allocated to support high facilitation and action learning. This CRCT has also reported that a top down approach is required for GSFCH implementation as many care homes have a closed communication culture around death and dying.[271] Therefore, nursing managers reported that action learning is a useful form of facilitation and must be actively engaged to develop local guidelines and initiatives for successful GSFCH implementation.[271]

GSFCH had also resulted in a cultural transformation of EOLC for residents and their families through proactive care planning, information and assessment of symptomology and appropriate anticipatory medications in place to support residents in a timely and coordinated fashion and improved staff and carer confidence to manage the challenges during EOLC.[270] The programme promoted robust governance through improving standards and accreditation and thus resulted in ongoing good practice and continuous improvement and will impact on the future results of the National Audit of Care at the End of Life (NACEL) 2021/22.[270,272]

2.1.9. Digital Healthcare in Care Homes

Monitor was an executive non-departmental public body of DH whose main duty was to protect and promote the interests of NHS patients and therefore with NHS England calculated that a combination of a growing demand, lack of annual efficiencies and flat real term funding could produce a gap between resources and patient needs of nearly £30 billion a year by 2020 in the NHS.[273] As briefly outlined in Chapter 1, the Five Year Forward View was developed to reduce and/or avoid the performance gap due to the £30 billion funding gap by: reducing demand and improvement gaps (upgrading prevention health), narrowing expansion gaps (increasing primary and social care funding) and reducing the diversification gap (enhancing digital care).[2] One of *The Five Year Forward View* vanguard's was aimed to improve care to residents in care homes through offering more support to frail care home residents by combining NHS, GP and social services to reduce long term care home admissions and reducing avoidable hospital admissions by ensuring that care home residents get their health needs regularly assessed and met.[2] Based on the above, the DH released a report entitled: *Prime Minister's Challenge on Dementia 2020* which focused on increasing awareness and understanding of dementia, improving the diagnostic rate and accuracy of dementia, empowering GPs to ensure continuity of care and ensuring HCPs receive training to support their role and driving research and innovation to improve the quality of dementia care.[274]

In 2007, a study investigated the ability to use a 2-way interactive video technology on 8 patients with mild dementia to improve medication self-administration accuracy, monitor medication compliance and improve mood.[275] After 4000 contacts, this study reported an adequate outcome in 82% of calls and a statistically significant difference ($p<0.05$) in medication compliance (81% as compared to 66% medication compliance in the control group).[275] This study also reported that TH monitored patients' medication compliance remained stable during the study and was significantly different to the control group whose compliance fell 12% during the study.[275] Common themes identified during this study were decreased caregiver worry, increased medication compliance and social support, improved nursing home placement, increased technology issues, and increased medication delivery problems.[275]

In 2014, Fleming and Sum's[276] systematic review (41 studies) to evaluate the effectiveness of assistive technology in the care of people with dementia, defined

assistive technology as a product, equipment, or device, usually electronic or mechanical in nature, which helps people with disabilities to maintain their independence or improve their QoL and is focused on communication, independence, leisure, and lifestyle, prompts and reminders, safety and security, communication and TH and therapeutic interventions. They concluded that they were unable to establish that using assistive technology to increase independence and compensate for memory problems in people with dementia was effective due to small samples, high drop-out rates, very basic statistical analyses, and lack of adjustment for multiple comparisons and poor performance of the technology.[276]

Penny et al.[277] published systematic review (9 qualitative studies) evaluated nurses and midwifes experiences of using videoconferencing in practice. They identified that whilst videoconferencing was useful on a continuum and offered a broader range of information, it also had implications for professional practice and that barriers (time, practicality and video and sound quality) to videoconferencing existed and technical support, training and encouragement were required. They therefore concluded that understanding potential benefits and limitations, the training and support required and addressing potential professional implications will influence adoption and ongoing use of videoconferencing.[277]

The FamTechCare® RCT that recruited 106 caregivers and 83 patients with dementia received feedback from dementia care experts who evaluated mobile video captured (Intervention videos=784, Control videos=253) to help them better manage challenging care situations. The intervention group (50 caregivers and 42 patients with dementia) received feedback weekly whereas the control group (56 caregivers and 41 patients with dementia) at the end of the study.[278] Significant outcomes reported in the intervention group included reduced caregiver depression (p= 0.012), gains in competence (p=0.033) and those living in rural areas also had a significant reduction in depression (p=0.002) for caregivers.[279] Non-significant reported improved outcomes included managing dementia behaviours, understanding disease expectations and performing activity of daily living care.[280] FamTechCare® also reported that its system was more expensive when compared to the standard care of telephone support due to the cost of equipment, recording application and expert panel time and was slightly above ($36.38) the caregiver's willingness-to-pay threshold ($36).[281]

A review of 30 studies in 2018, has reported that TH can be used to screen for mild cognitive impairment or cognitive decline and therefore dementia can be diagnosed via video consultation.[282] In 2019, Lorenz et al.[283] aimed to identify how technology-based tools and services fit within the dementia care pathway for people with dementia and carers. Classification of technologies included care delivery, memory support, safety and security, training, and social interaction whilst users were classified as people with dementia (mild cognitive impairment/early stages of dementia and moderate to severe dementia), unpaid carers and HCPs.[283] Care settings were classified as either community or institutional.[283] They reported that the largest number of technologies existed in the community setting and were mainly passive monitors e.g. smoke detectors whilst the second largest number of technology supports memory e.g. global positioning systems with voice prompts for people with mild dementia.[283] A third group of technology emerged from the literature and supported memory and therapeutic care functions for both people with dementia and carers.[283] Interestingly, Lorenz et al.[283] reported that there is very little evidence of widespread practical application of technologies and that stakeholders re-purpose standard technologies to meet their needs.[283]

2.1.9.1. Albany Lodge

Albany Lodge (AL) is a privately owned 100 bed nursing home in Croydon providing intermediate, general, and Elderly Mentally Infirm (EMI) nursing care to patients over the age of 65 for long and short-term stays. It is registered to care for patients in the following specialist categories: adults over 65 years old, dementia, mental health conditions and physical disabilities. Level One of AL (Park Lane Suite) is residence to patients with moderate dementia. Staffing consists of six nurses and three rotational activity coordinators assisting six carers. Nurses work a twelve-hour shift from 8am to 8pm or 8pm to 8am. There is a maximum of one nurse and one manager on duty in Park Lane Suite at any point in time. Carer and activity coordinator staffing levels are calculated based on ward activity. All record keeping was paper based at the time of this study. HCPs e.g. 5 GPs, Rapid Response Team (RRT) (two nurses, one manager and one community geriatrician) and London Ambulance service (two paramedics) support the care of residents and are directly involved in hospital admissions of

residents when required. The HCP team and organisations involved in the care of patients in AL is depicted in Figure 2.1.

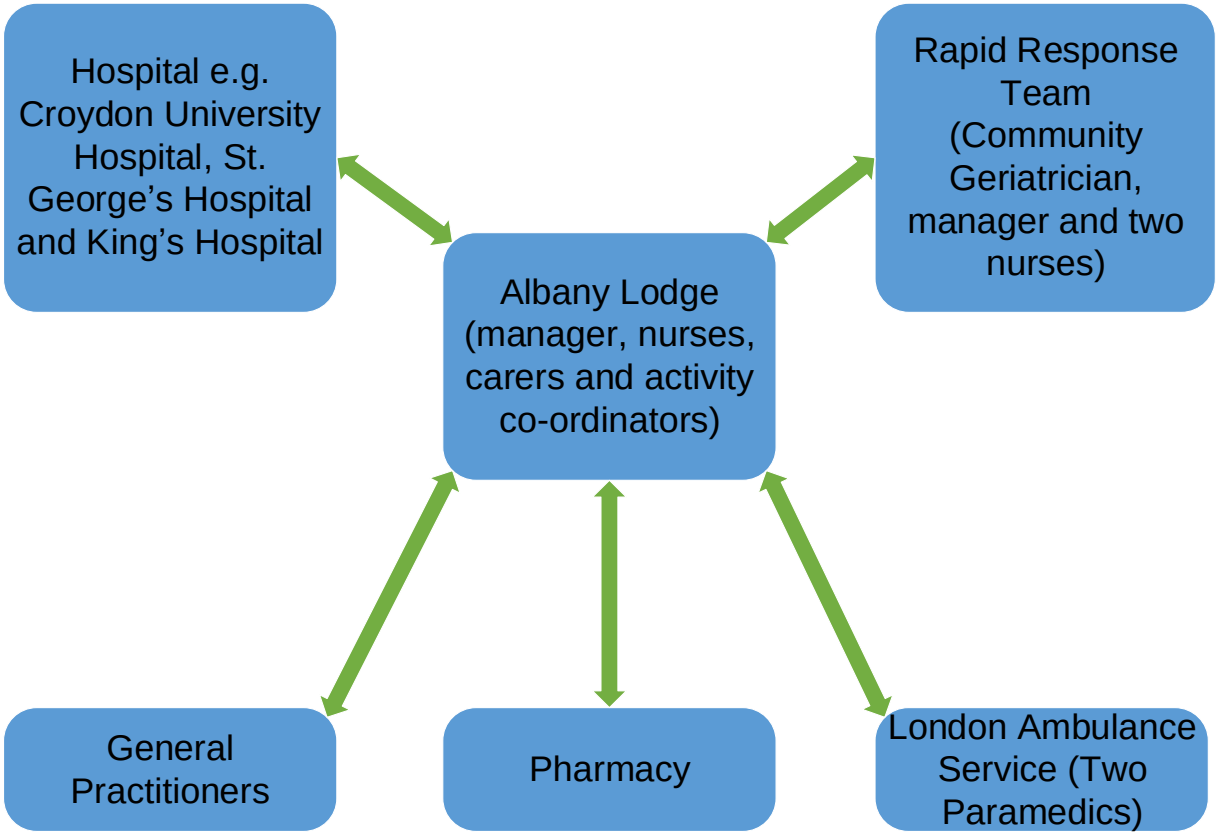

Figure 2. 1: AL Healthcare Professional Stakeholders

2.1.9.2. Telehealth Implementation at Albany Lodge

For the purposes of this chapter, THS is defined as a system that allows remote exchange of data between residents in a care home and HCPs (Monitoring Centre) to assist in the management of dementia. TH has the potential to offer the opportunity to monitor a care home residents' health status regularly through a person centered care system that provides early detection of any deterioration in health and thus reducing hospital admissions and improving outcomes.[44,177] The Croydon CCG (CCCG) had commissioned Tunstall Healthcare UK® to provide a remote patient monitoring (RPM) service to AL and this service was implemented on 15th August 2016. This service allowed monitoring of vitals using peripheral devices e.g. blood pressure monitors, pulse oximeters, thermometers, and a weighing scale. Active participation from care home residents, carers and system users was required in sending, receiving, and assessing data. The THS randomly selected residents on a Tuesday or Wednesday weekly to have their vitals taken and if any readings taken are out of the range of guideline parameters, a text message is sent to the RRT who then contacts the nurse at AL to ensure the resident receives early medical intervention as required. The text alert system was activated on the 15th February 2017 by the principal investigator (PI) who retired shortly thereafter. A Cluster Matron in Croydon was then allocated the role of PI to continue this study.

A THS needs to be implemented successfully to be effective. As outlined in chapter 1, barriers to the successful implementation of a THS have been reported to include lack of resources, organizational support, stringent patient inclusion criteria, technical support and health professional uncertainty.[70] HCPs' uncertainty can be reduced by having a strategic change management plan, structured support and adequate training for HCPs, and 'champions' who support and promote the service.[70,284–290] The clear potential of TH to proactively improve care and clinical outcomes in care homes was the impetus behind this study.

2.2. Aim and Objectives

This study aimed to evaluate the feasibility of using a digital healthcare solution for early monitoring of residents with dementia in a care home. This aim was divided into the following objectives:

- To measure the response frequency of general practitioner visits (GPV), non-elective hospital emergency department (ED) and inpatient (IP) visits and antibiotic prescriptions (AP) in the care home before and after the implementation of a structured monitoring THS.
- To explore the multidisciplinary HCPs' awareness and experiences of TH and their perceptions of it pre and post implementation in the care home.

2.3. Evaluation Methodology

To measure the response frequency of additional GPV, ED and IP visits and AP in AL, the care pathways before and after the implementation of the THS is described below. This pilot study was designed to assess the feasibility of the implementation and the value contribution of TH for residents with dementia in care homes.

2.3.1. Standard Care Pathway

Before TH, if an AL resident was noticed to be unwell by a carer, the nurse would have been notified. Depending on the urgency and timing of the event, the nurse could have contacted any of the following HCPs for support: RRT, GP (normal or after hours) and/or London Ambulance Service (LAS). Depending on the feedback from the HCP, a second referral from one HCP to another might occur e.g. RRT could advise the nurse to monitor the resident and contact the GP if the health status of the resident changes. The endpoint of this referral may result in an unplanned hospital admission at Croydon University Hospital (CUH) ED. The normal care pathway for an unwell resident before TH is depicted in Figure 2.2.

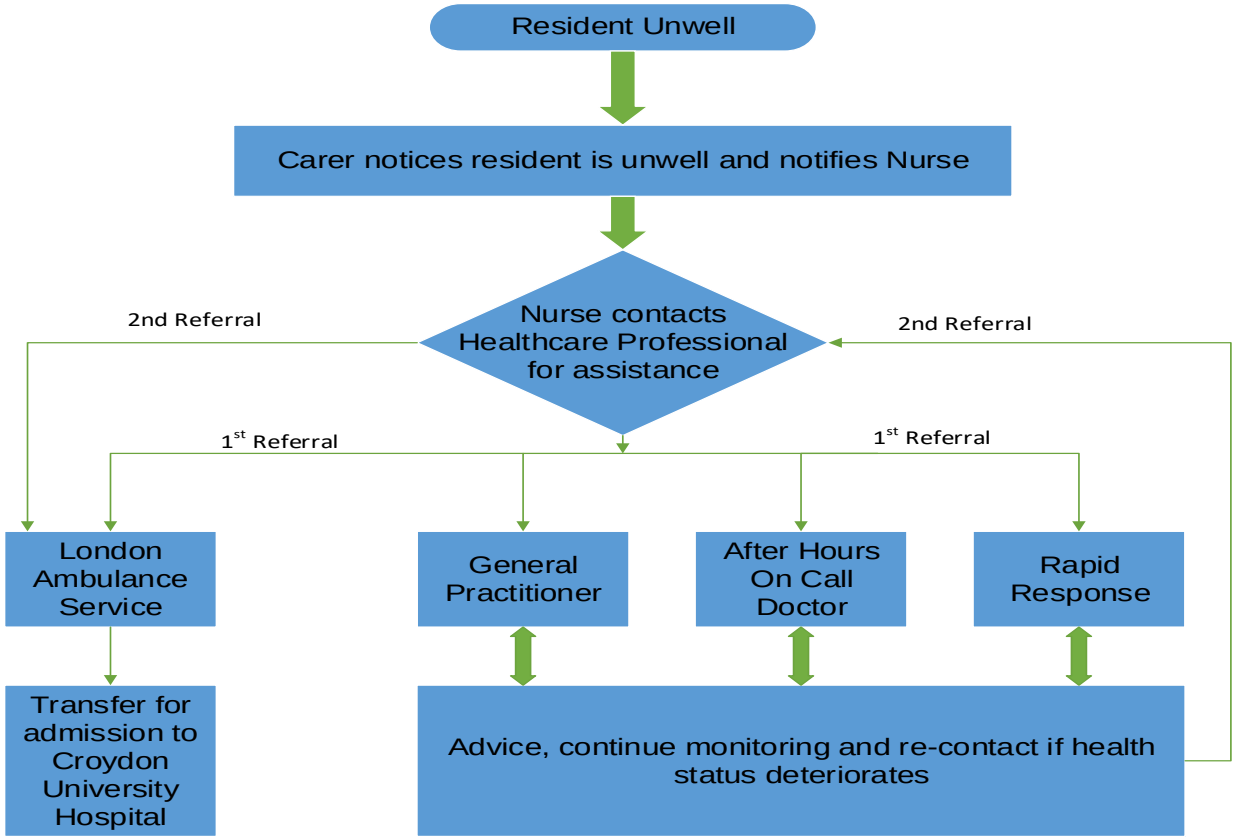

Figure 2. 2: Care Pathway for Unwell Residents before Telehealth

2.3.2. Telehealth System (THS)

The Tunstall myClinic® THS is a portable THS that enables multiple residents to be monitored. Four peripheral devices were connected to the myClinic® THS to measure vital signs (blood pressure, temperature, oxygen saturation and weight) together with health questions to assess the resident's health status:

1. Is the person unusually upset, fidgety, agitated or less cooperative today?
2. Has the person developed a new cough or is breathless today?
3. Is the person refusing to drink or eat today?
4. Does the person's urine smell or is a different colour today?
5. Is the person more confused or sleepier than usual?

A standard acceptable parameter range for vital signs was programmed into the Tunstall myclinic® THS:

- Blood Pressure: Systolic Blood Pressure= 95-170 mmHg and Diastolic Blood Pressure= 60-95 mmHg
- Temperature= 35.5-37.5°C
- Pulse= 50-100bpm
- SpO_2 > 92%

2.3.3. Study Phases and Setting

AL had received the Tunstall myClinic® THS on 15th August 2016. The PI recruited residents with mild dementia and registered them on the THS. Nurses and Carers involved in the deployment and usage of the THS were invited to a training session to demonstrate the usage of the THS. This training included teaching nurses and carers how to use the peripherals to take measurements and how to dock the THS to ensure transmission of data and recharging of the THS. This pilot study was therefore divided into three phases (Figure 2.3) with each phase consisting of a six-month duration: Control Phase (CP, n=27): 15th February 2016 to 14th August 2016, Active Monitoring Phase (AMP, n=27): 15th August 2016 to 14th February 2017 and Active Monitoring with Text Alerts Phase (AMTAP, n=14): 15th February 2017 to 15th August 2017.

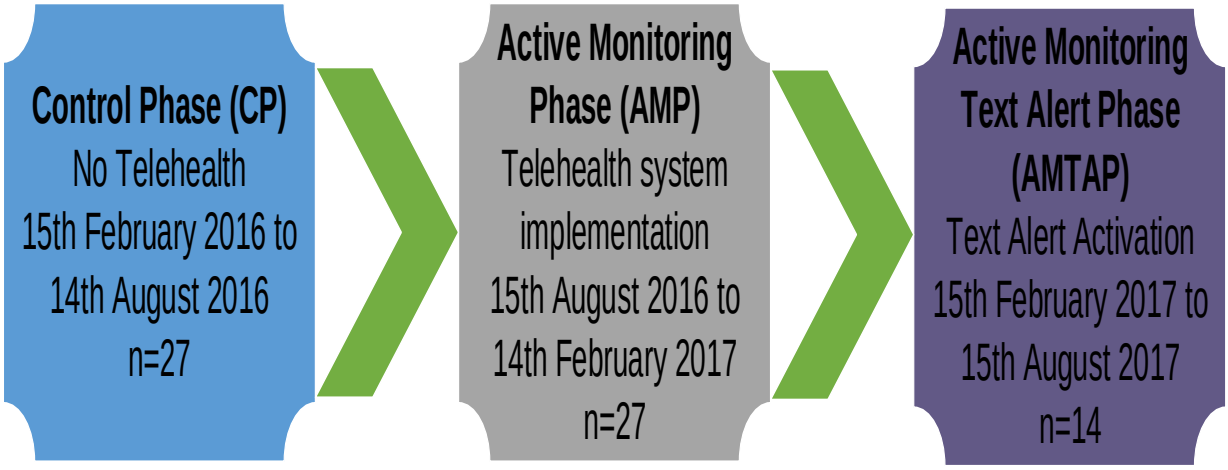

Figure 2. 3: Study Phases

During the AMP, the Tunstall myClinic® THS automatically selected residents that were registered on its system on either Tuesday or Wednesday morning and directed AL HCPs (carers and nurses) to assess each resident using both pre-selected medical peripherals e.g. thermometer, blood pressure cuff and weighing scales, and health questions. Under the supervision of a nurse at AL, the answers to the questions and vital signs readings for each patient were recorded in the Tunstall myClinic® THS. This information was securely transmitted on Tuesday and Wednesday during office hours to a central server located at a local Aztec® operated monitoring centre (see Figure 2.4). Aztec® conducted technical and non-clinical triage using a traffic light system of red, yellow or blue alerts based on NICE Clinical for example, guideline 143: Fever in under 5s: assessment and initial management (2019).[291] During the AMP, whilst the Tunstall myClinic® THS may have generated alerts, no text alerts were sent to the RRT. The PI activated each user's monitoring plan on 15th February 2017 resulting in RED and YELLOW system generated alerts which were then texted to the RRT during AMTAP.

The Tunstall myClinic® THS would generate "RED" Significant alerts if the HCP answered "YES" to any of the health questions above or if any of the vital sign readings recorded were not with the standard acceptable vital sign parameter range. A "Yellow" incomplete alert is generated if the resident has skipped using a peripheral that records vital signs e.g. blood pressure machine. A "Blue" missed alert is generated if the resident has missed their scheduled interview and thus was not included in a text alert. If the system generated a Red or Yellow alert, local operators at the monitoring centre (see Figure 2.4) texted the clinical data to the RRT so that they could notify a clinician or emergency services if necessary. Red or significant alerts create the opportunity to

action an early intervention to prevent or minimise imminent clinical deterioration. The Rapid Response Nurse (RRN) can then contact the care home to offer advice, schedule a visit, or take other action as appropriate. Figure 2.4 shows the flow of clinical information from taking the readings to alert text messages being sent to the RRT. The PI and the researcher also received the text alerts for system monitoring purposes but did not intervene in the triage or response to text alerts.

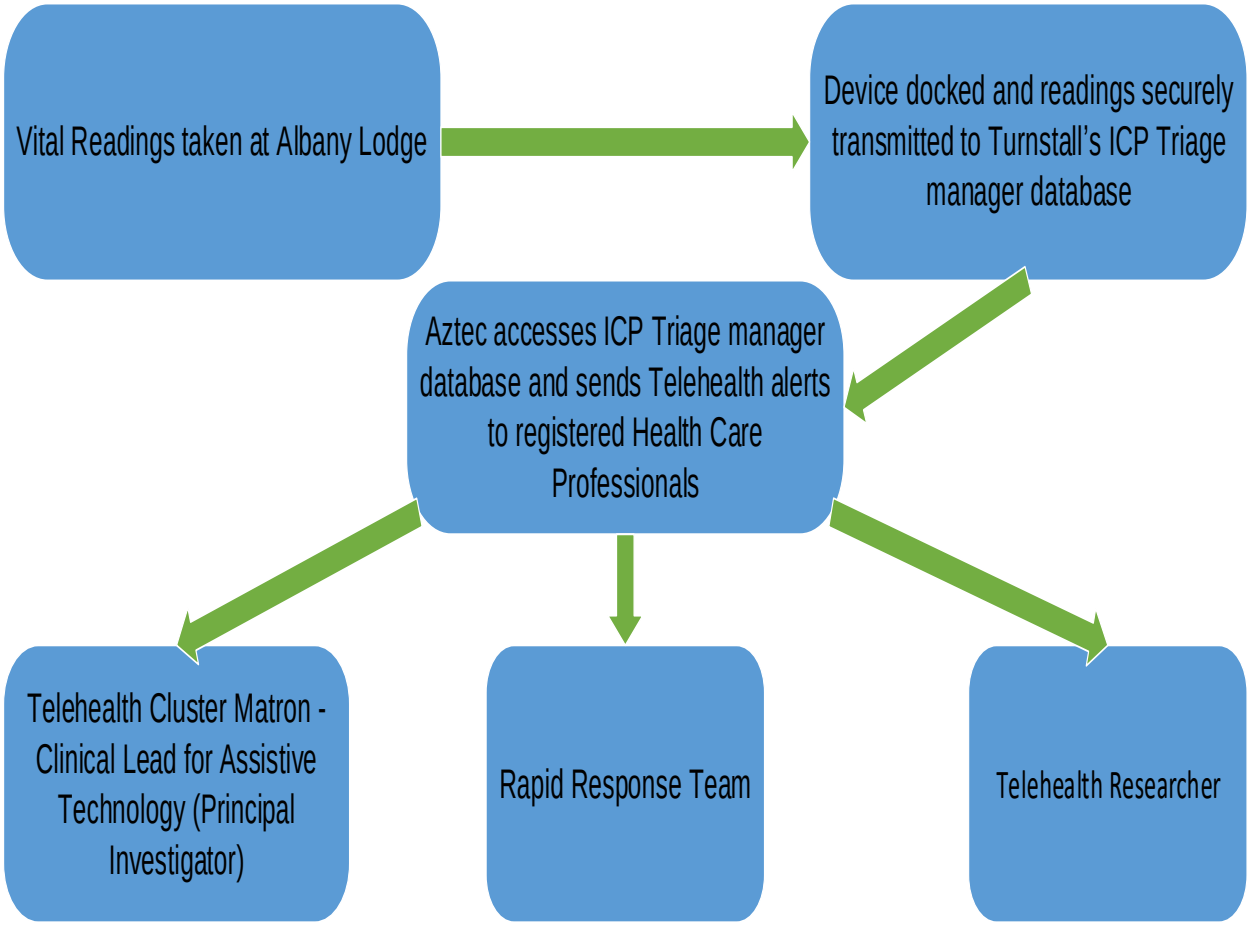

Figure 2. 4: Health Information Text Alert Pathway for Unwell Residents

Once the RRT received a text alert, the care home was contacted by the RRN and based on the feedback and clinical information received from the AL nurse, the RRN would consider three options as a response:

- AL nurse reports that resident is normal and well - No action.

- AL nurse reports that resident is abnormal but well - Advice provided - AL nurse would be advised to monitor resident and contact the RRT, GP or 999 if health status of resident changes.
- AL nurse reports that resident is abnormal and unwell - RRT visit or GP or 999 contacted and post resident evaluation by the RRN results in AL nurse being advised to contact GP or 999 directly.

Thus, the care pathway for an unwell resident since the implementation of TH is as depicted in Figure 2.5.

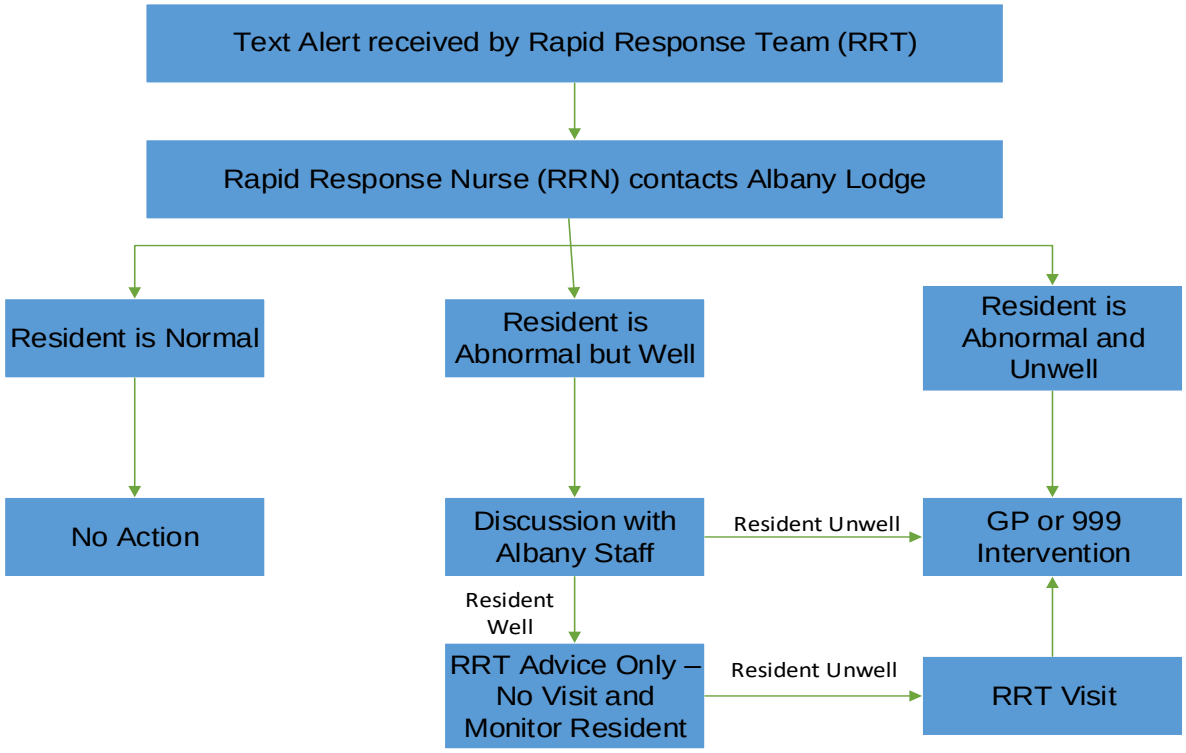

Figure 2. 5: Care Pathway for Residents once Text Alert received by Rapid Response

2.3.4. Participant Recruitment Strategy

Inclusion criteria required that participants had moderate dementia (MMSE score = 13 to 20 points), must have the physical ability and be willing to use the monitoring peripherals, clinically stable on recruitment and have capacity to consent or have an appointed carer/GP to consent or have an appointed carer/GP to consent on their behalf following a 'best interest' meeting. Participants were excluded from recruitment if consent or the advice of a consultee cannot be obtained. Withdrawal criteria allowed

individual participants to be able to withdraw from the study evaluation at any time. Most importantly, prior to the evaluation, the carers or nurses involved in the regular care of the resident had to also support the recruitment process as they had the best understanding of the residents' capacity and willingness to participate. Consent forms were signed by the residents or appointed carer/GP if participants were unable to sign the consent form. All participants and/or carers/GPs were given participant information sheets providing a clear explanation of the activities involved, a brief summary of aims of the study, background information and rationale of the study, expectations of participants and usage of data collected, risks in study participation and information on the right to withdraw from the activity at any time.

Level One of AL (Park Lane Suite) was residence to patients (n=27) with moderate dementia (MMSE score = 13 to 20 points) who were recruited to participate in the study and therefore, a total sample population of 27 residents (see Figure 2.6) were identified as suitable for TH and their GPs were notified. Unfortunately, 4 residents died during the AMP and 2 residents died during the AMTAP. A total of 7 residents were suspended from active monitoring as they were deemed unsuitable during the AMP due to lack of co-operation in using the monitoring peripherals despite consenting to the study. The remaining 14 residents (see Figure 2.5.) had their clinical information monitored and recorded monthly using data reports from the Tunstall myClinic® system. If patients were admitted to CUH during the study phases, the Cerner system was accessed to obtain relevant clinical event information.

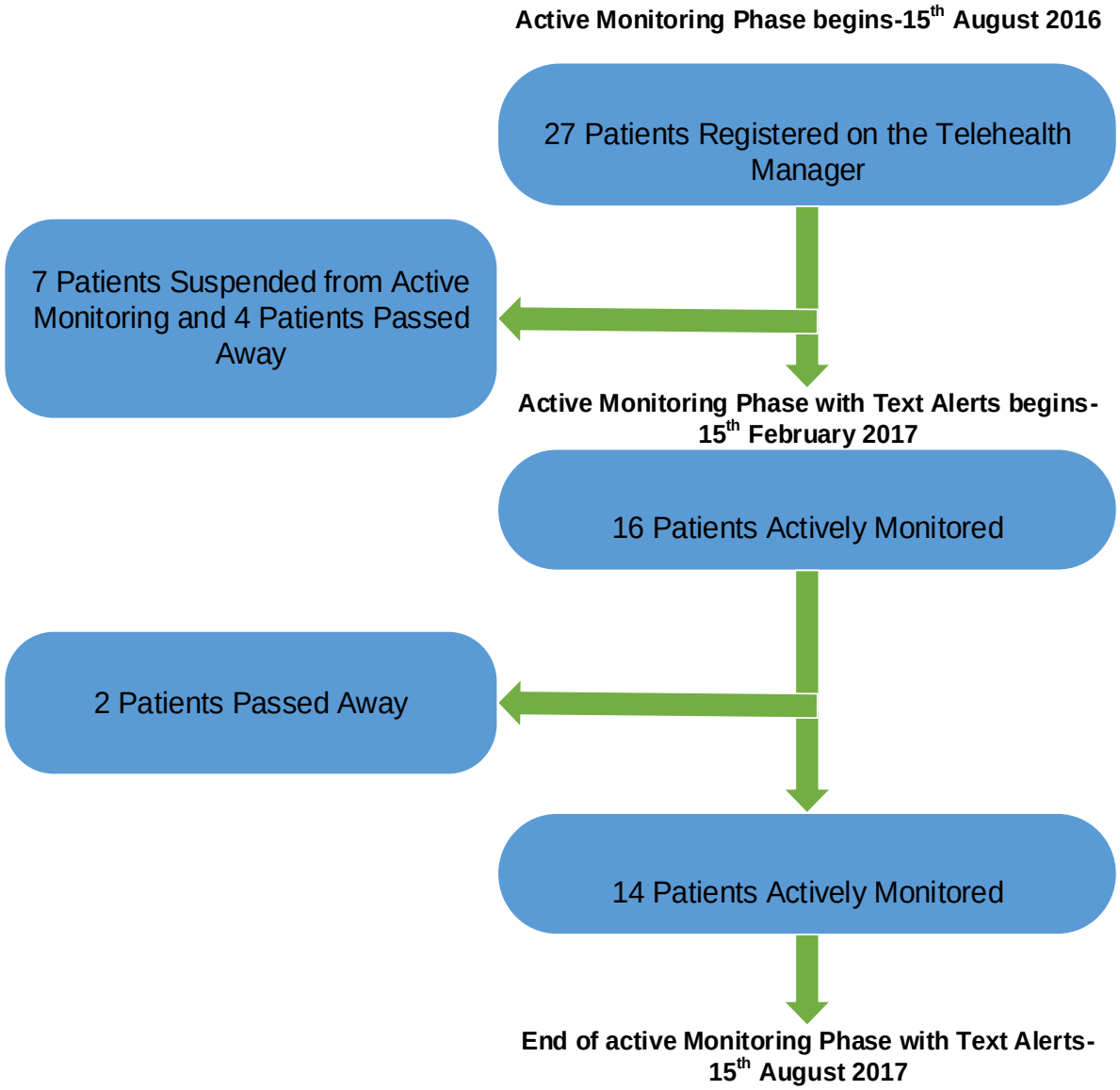

Figure 2. 6: Patient Selection Criteria

2.3.5. Clinical Outcomes

This is a before-after study. To compare the clinical effect of the Tunstall myClinic® THS, clinical outcomes were also measured for the CP. The clinical outcomes measured included the number of GPV, AP, ED, non-elective hospital admissions (IP) and rapid response interventions. Furthermore, TH text alerts and responses to the text alerts were measured before and after the implementation of the TH service and were compared for each resident. To accurately monitor the frequency of clinical events of participants, source documents used from AL for each resident included:

- Hospital letters sent to AL including discharge and referral letters to measure the response frequency of non-elective hospital ED or IP and confirm clinical findings and further investigations and treatments required.
- Albany clinical records from GPs; carers; nurses and correspondence from external healthcare organisations containing clinical information e.g. symptoms, incidents, tests ordered, medical interventions, communication and referral to other HCPs and treatments prescribed to measure additional GPVs.
- AL medication administration charts and pharmacy records of medication issued to AL to confirm medication issued to residents to measure the frequency of AP in the care home before and after the implementation of the THS(Appendix 4-7).

2.3.5.1. Statistical Analysis

All statistical analysis was performed using the Statistical Package for the Social Science (SPSS) for Windows version 26. The frequency of clinical outcomes in each phase, text alerts and medication changes were calculated and expressed as numbers and percentages. The mean duration of IP admission was also calculated.

The frequency (minimum, maximum, mode and median) and location of medication changes (reduce dose, increase dose, stop, start or replace medication) was calculated per phase. To aid the analysis, medications were classified based on the body system they act on using the British National Formulary 82 (2021).[292] They were also classified based on ARS[257] and whether they are high risk and whether they are known to cause high risk of falls based on the All Wales Medicines Strategy Group Polypharmacy: Guidance for Prescribing.[256] The mean CPS during CP, AMP and AMTAP was also calculated. In addition, the frequency, Relative Risk Reduction (RRR) and Odds Ratio (OR) of falls per phase was calculated (95% CI) including the frequency of falls on Albany Falls Register and the frequency of hospital admissions due to a fall.

Due to the small sample size ($n<30$), the area of study is better represented by the median and nonparametric statistical techniques.[293] Testing the paired data using Shapiro Wilk was recommended for sample sizes < 50 and yielded a non-symmetrical/non-normal ($p<0.05$) distribution of the data (Table 2.1).[294–296] Therefore, as the data was mainly paired and non-symmetrical, the Sign test was used to test the difference in medians between matched pairs e.g. CP vs AMP or CP vs AMTAP (n=27,

or n=14 as appropriate). The 'Exact Test' option was used for all tests performed in SPSS to calculate a more accurate p-value when working with small sample sizes. Kendall's Tau was selected to determine the correlation between two variables as it has an intuitive interpretation (concordant pairs-discordant pairs). It thus gives a better estimate of the corresponding population parameter and more accurate p-values in smaller samples sizes.[297] The strength of Kendall's Tau correlation (τb) can be categorised as weak (<0.3), moderate (0.3 to 0.49), strong (0.5 to 0.0.89) and very strong (0.89 to 1).[297] p-Value was set at <0.05 for significance.

*Table 2. 1: Test of Symmetry: Shapiro Wilk p-values**

	CP vs AMP (n=27)		CP vs AMP vs AMTAP (n=14)		
GPV	0.005	0.031	0.041	0.113	0.026
AP	0.000	0.001	0.000	0.000	0.000
ED	0.000	0.000	0.002	0.000	0.002
IP	0.000	0.000	0.002	0.000	0.002

GPV=General Practitioner Visits, AP=Antibiotic Prescribed, ED=Emergency Department, IP=Inpatient Admission

2.3.6. HCP Perceptions

A qualitative study consisting of face-to-face interviews using semi-structured open-ended questions was conducted with HCPs before and after the TH service was implemented to explore their awareness and experiences of TH and their perceptions of its implementation in a care home. Nurses, carers, paramedics, manager, Rapid Response Nurses, Rapid Response Manager and general practitioners involved in care of participants were invited to participate in the interviews both pre-AMP and post-AMPTAP. To improve reliability and validity of data, the identical nurses, carers, paramedics and general practitioners were interviewed both pre-AMP and post-AMTAP. Open ended semi-structured questions allowed the participants to freely express their perceptions about TH and prompted them to discuss the issues related to TH in care homes in more depth. Scheduled one-to-one interviews were conducted with each stakeholder, apart from carers, in a private meeting room to allow interviewees to feel comfortable to respond to semi-structured open-ended questions and confidentiality of responses was maintained through the study. Carers were invited to a focus group interview session that was held one hour prior to the start of their rotational shift (Day

and Night). Two focus group sessions were conducted pre telehealth system implementation and another two were conducted post telehealth system implementation. This approach has been cited to maximise group homogeneity and interaction and ensure that sample size is adequate within each group to achieve data saturation.[298] See Section 2.3.6.1.B. for interview analysis methodology.

2.3.6.1. HCP Recruitment

2.3.6.1.A. System Usability Scale (SUS) Analysis

Participants were asked to evaluate the current THS using the System Usability Scale (SUS).[299] SUS is a quick and reliable 10 item industrial standard questionnaire with five response options ranging from Strongly agree to Strongly disagree and can be used to measure usability on a wide variety of systems. The SUS questionnaire was ideal as it allowed HCPs to respond quickly and accurately and has high accuracy especially when testing small samples of HCPs.[299] Having been cited in over 15000 articles and publications, SUS is not only a reliable measure of usability but also has high validity as it can effectively differentiate between usable and unusable systems.[299] The SUS scores fall within the range of 0 (negative) to 100 (positive). A system is considered acceptable if the SUS score is above 70 (Appendix 8).[300]

2.3.6.1.B. Interview Analysis

All interviews were transcribed into computer-assisted qualitative data analysis software; NVIVO 11®. The pre and post TH perceptions of HCPs and management were analysed using the 7-step Framework method and TDF model to provide a robust theoretical basis for the analysis of TH implementation including identifying barriers to successful technology implementation and solutions to enhance technology adoption.[138,301,302] The steps followed are described below:

- Step 1: Interviews were transcribed, and their accuracy verified by reviewing audio recordings and transcripts simultaneously.
- Step 2: Transcripts were read several times and notes were made next to each relevant quote.
- Step 3: Pre and post TH implementation transcripts were reviewed to reveal the most salient thoughts expressed by HCPs that were inductively primarily coded using coding methodology proposed by Corbin, Strauss and Attride-Stirling in 2001.[303,304] The pre TH interviews yielded 31 relevant quotes (Appendix 12) whilst the post interviews yielded 318 relevant quotes (Appendix 13).
- Step 4: A working analytical framework was developed defining each code. (Appendix 9). Codes were grouped into the DTF overarching categories. This

process was repeated until all codes were categorised. This resulted in the 37 codes (Table 2.2) derived that were discrete enough to avoid redundancy whilst still retaining the global meaning of thoughts expressed in meaning of quotations classified under 9 DTF categories e.g. knowledge, awareness and understanding. These codes were based on the theoretical implementation of TH in a care home and linked the experiences of HCPs both before and after the implementation of TH and identified their future intentions of using TH.

Table 2. 2: Pre and Post Codes and Themes

	Pre-Telehealth Themes						Pre and Post Telehealth Themes		
	Post Telehealth Themes								
	Knowledge, Awareness and Understanding	Barriers	Goals and Beliefs	Environmental Context and Resources	Professional Role Identity	Emotion and Optimism	Memory and Re-Inforcement	Behavioural Regulation	Future Intentions
Codes	Positive Experience	Increased staff anxiety	Improved Clinical Effectiveness	Previous delays in seeking medical advice on time	Loss of Professional Skill	Optimism	Technology Adoption	Increased Monitoring	Future - Diseases
	Previous Knowledge, Awareness and Understanding	Inadequate Staff	Improved Clinical Efficiency	Current high hospital admission rate	Improved HCP relationships	Future priority	Ease of Use		Future - Increased frequency of monitoring, training, feedback, awareness and understanding
	No previous knowledge	Inadequate Training	Less workload than expected	Inadequate Clinical Alignment	Improved Professional Role	Not a future priority			Future - Residential or Care Homes
	Improved Knowledge, Awareness and Understanding	Lack of GP support	Inadequate Clinical Effectiveness	Equipment Suitability					Future Clinical Alignment
	No change in Knowledge, Awareness and Understanding	Lack of management support							Future HCP collaboration
		Equipment Failure							Future support
		Poor Implementation							
		Poor recruitment							
		Poor communication							

- Step 5: The analytical framework was applied to each transcript using NVIVO 12®. Important quotes were linked to codes.[303,304]

- Step 6: Codes were linked to organising and global themes and frequencies were summarised into a framework matrix using NVIVO 12® (Appendix 11 - 14).[138,301,302] Deductive quotes were linked and referenced to previously cited TDF theory whilst inductive quotes were indicated (Appendix 11 and 14).

- Step 7: Basic and organising themes were liked to global themes for each quote for both the pre and post interviews.[138,304]

Four to five quotations that strongly expressed the opinions of HCPs within each global theme were selected for the results section. The frequency of pre and post TH quotations per code and global theme for each category of HCP are available in Appendix 12 and 13 respectively. Using the above methodology, the next section displays the results of comparing both clinical outcomes and HCPs' perceptions pre and post implementation of a THS at AL.

2.3.7. Ethical Approval

This study was approved by SEC Research Ethics Committee (REC) at Kingston University (1718.005.1) and by the Croydon Clinical Commissioning Group as a service evaluation and feasibility study.

2.4. Quantitative Results

2.4.1. Resident Demographics and Past Medical History

Table 2.3 shows that a total of 27 residents with mild dementia were recruited into CP and AMP consisting of 22 females and 5 males. Unfortunately, only 12 females and 2 males were able to complete the AMTAP of the study. The median age of residents participating during the CP and AMP and AMTAP was 86 years old with a range of 57 to 101.The AMTAP had a higher prevalence of residents with co-morbidities than CP and AMP for example: hypertension (57.1% vs. 40.7%), type 2 diabetes (14.3% vs. 7.3%), hyperlipidemia (57.1% vs. 37%), arthritis/osteoarthritis (37.5% vs. 33.3%) and cardiovascular disease (CVD) (42.9% vs. 37.0%). Residents had a slightly higher historic prevalence of CVA (50.0% vs. 33.3%) and constipation (71.4% vs. 70.4%) but a slightly lower prevalence of UTI (28.6% vs. 37.0%) and falls (50.0% vs. 55.6%) during AMTAP than CP and AMP. Although thirteen (48%) residents did not complete the study, the comorbidities and past medical history of participants that completed the study is similar in characteristics to the original recruited sample of participants.

Table 2. 3: Summary of Residents Demographics, Comorbidities and Past Medical History during CP, AMP and AMTAP

		CP & AMP* (n=27)	**AMTAP* (n=14)**
Gender		22F/5M	12F/2M
Age Median (±SD) years		86.0 (9.1)	86.0 (8.3)
Age	57 to 70 years n (%)	2 (7.4)	1 (7.1)
Age	71 to 80 years n (%)	4 (14.8)	1 (7.1)
Age	81 to 85 years n (%)	4 (14.8)	3 (21.4)
Age	86 to 90 years n (%)	10 (37.0)	5 (35.7)
Age	91 to 95 years n (%)	6 (22.2)	3 (21.4)
Age	Greater than 100 years n (%)	1 (3.7)	1 (7.1)
Co-M*	Hypertension n (%)	11 (40.7)	8 (57.1)
Co-M*	Diabetes Type 2 n (%)	2 (7.4)	2 (14.3)
Co-M*	Hyperlipidaemia n (%)	10 (37.0)	8 (57.1)
Co-M*	Arthritis/Osteoarthritis n (%)	9 (33.3)	5 (37.5)
Co-M*	Cardiovascular disease (CVD) n (%)	10 (37.0)	6 (42.9)
History	Cerebrovascular Accident (CVA) n (%)	9 (33.3)	7 (50.0)
History	Constipation n (%)	19 (70.4)	10 (71.4)
History	Urinary Tract Infection (UTI) n (%)	10 (37.0)	4 (28.6)
History	Falls n (%)	15 (55.6)	7 (50.0)

*CP= Control Phase, AMP= Active Monitoring Phase (AMP), AMTAP= Active Monitoring Phase with text Alerts and Co-M = Co-Morbid Conditions

2.4.2. System Significant Text Alerts

Table 2.4 shows the frequency of various alerts generated per resident. A total of 350 alerts were generated consisting of red, yellow and blue alerts during AMTAP. Red clinically significant alerts (n=136, 39%, range: 3 to 23) were generated when residents' vital observations were detected to be outside the set parameter range or when they responded positively to any of the health questions and a red alert represented an opportunity for residents to receive an earlier health intervention.

The yellow incomplete alerts (n=147, 42%, range:0 to 20) were generated when residents did not or refused to use a peripheral that records vital signs e.g. the blood pressure cuff hurt residents, or the in-ear thermometer was rejected due to its invasive nature. If the THS generated a red and a yellow alert for a resident, the non-clinical triage assistant at Aztec combined the alerts into one text alert that was sent to RRT. RRT had to review text alerts and decide which text alerts to respond to. A total of 199 text alerts containing 63 only yellow alerts, 52 only red alerts and 84 consisting of mixed yellow and red alerts, as were combined were sent from Aztec to RRT. However, RRT only received 168 of the 199 text alerts sent to them due to a temporary user error and therefore 31 (15.6%) text alerts were not received by RRT. RRT only responded to 52 (31%) text alerts as these were the only clinically significant red text alerts that were not associated with yellow alerts corresponding to 5 patients. None of the residents required that all their text alerts to be responded to by the RRT. The extra texts that were not responded to by the RRT represent an extra cost and time driver of TH processing and RRT triaging as a response was deemed to be clinically unnecessary by the RRT for 116 (69%) of the text alerts. It is important to note that seven residents that were excluded from the AMTAP would have generated additional unnecessary text alerts that would have increased the workload on triage team and the RRT without achieving any significant clinical outcomes e.g. a resident being agitated with the TH equipment will generate a high blood pressure text alert as their blood pressure was high during monitoring but is otherwise normal.

Blue missed alerts (n=67, 19%, range: 0 to 19) were generated if the resident had missed their scheduled interview questions. During AMTAP, there were 336 monitoring opportunities (14 residents x 4weeks x 6months), and the yellow and blue alerts represent a missed opportunity to use the THS to support the care of a resident (n=214, 63.7%, 2.6 interventions per resident per month). These percentages have even greater

significance as there was only 14 residents participating during AMTAP and represent system noncompliance.

Table 2. 4: Frequency of THS Alerts, Text Alerts and RRT Response per Resident

	System Generated Alerts n (%): Total 350 Alerts						Text Alerts	RRT Response
	Missed (Blue)		Incomplete (Yellow)		Significant (RED)			
AL1	4	16%	14	56%	7	28%	14	1
AL2	8	32%	6	24%	11	44%	11	5
AL3	4	16%	13	52%	8	32%	13	3
AL4	9	36%	13	52%	3	12%	13	3
AL5	6	24%	12	48%	7	28%	12	5
AL6	0	0%	7	28%	18	72%	18	6
AL7	1	4%	7	28%	17	68%	17	7
AL8	1	4%	15	60%	9	36%	15	3
AL9	19	76%	3	12%	3	12%	3	0
AL10	4	16%	9	36%	12	48%	12	3
AL11	2	8%	0	0%	23	92%	23	9
AL12	3	12%	16	64%	6	24%	16	3
AL13	0	0%	20	80%	5	20%	20	3
AL14	6	24%	12	48%	7	28%	12	1
Total	**67**	**19%**	**147**	**42%**	**136**	**39%**	**199**	**52**

As explained above, a red alert is generated when residents' vital observations were measured and were outside the set parameter range or when residents responded positively to any of the health questions. Therefore, there could have been more than one subcategory contained within a red significant text alert e.g. one red significant text alert would have been generated if both a resident's blood pressure and temperature were not within the set parameters, and/or a positive response was recorded to a health question. Table 2.5 shows that the above red significant alerts (n=136) contained 181 alerts from two categories: Health Questions (Subcategories A-E, n=23, 12.7%) and Vital Signs (Subcategories F-I, n=158, 87.3%). All subcategories of vital signs (see table 2.5) [F=81 (44.8%), G=25 (13.8%), H=28 (15.5%) and I=24 (13.3%)] generated a greater number of significant alerts than the health question subcategories [A=12 (6.6%), B=2 (1.1.%), C=4 (2.2%), D=0 (0%), E=5 (2.7%)]. Although the frequency of health question alerts was lower, they are of relevance to IP causes of admissions that were observed during this phase of the study. For example, pneumonia admission (n=1,

f=1), constipation and dehydration admissions (n=1, f=1), UTI related admission (n=1, f=1) and admissions for falls (n=4, f=6). It must be noted that whilst vital sign alerts were objective and were generated during vital sign measurement, that is, if vital signs were out of the pre-set parameter range, generation of health question alerts were dependent on the subjective response of the carer e.g. clinical and resident specific knowledge and experience.

Table 2. 5: Frequency of Significant Alerts per Category

	Number of Significant Alerts during AMTAP									Total	
	Health Questions					Vital Signs					
	A*	B*	C*	D*	E*	F*	G*	H*	I*	n	%
AL1	2	1	1	0	1	1	1	2	1	10	5.5
AL2	0	0	1	0	2	9	1	0	0	13	7.2
AL3	1	1	1	0	0	5	1	2	0	11	6.1
AL4	0	0	0	0	1	2	0	0	0	3	1.7
AL5	0	0	0	0	0	2	2	5	0	9	4.9
AL6	0	0	0	0	0	14	9	0	0	23	12.7
AL7	2	0	0	0	0	10	1	7	8	28	15.5
AL8	2	0	0	0	0	4	0	4	0	10	5.5
AL9	0	0	0	0	0	1	0	1	3	5	2.8
AL10	1	0	0	0	0	3	4	0	8	16	8.8
AL11	2	0	0	0	0	22	5	5	4	38	21
AL12	0	0	0	0	1	0	0	1	0	2	1.1
AL13	1	0	0	0	0	3	1	0	0	5	2.8
AL14	1	0	1	0	0	5	0	1	0	8	4.4
Total n (%)	12 (6.6)	2 (1.1)	4 (2.2)	0 (0)	5 (2.7)	81 (44.8)	25 (13.8)	28 (15.5)	24 (13.3)	181	100

*A= Is the person unusually upset, fidgety, agitated or less cooperative today? B= Has the person developed a new cough or is breathless today? C= Is the person refusing to drink or eat today? D= Does the person's urine smell or is a different colour today? E= Is the person more confused or sleepier than usual? F= Blood Pressure, G= Body Temperature, H= SpO_2, I= Pulse, n= Total Significant Alerts per resident

2.4.3. Clinical Outcomes

Table 2.6 shows the number of clinical outcomes during AMP versus CP (n=27). The number (n=7, 25.9%) of residents who had GPVs increased and the total frequency of GPVs, statistically significantly increased from CP (f=83) to AMP (f=142) (p=0.009). GPV was the outcome with the greatest increase per resident (f/n=10) from CP to AMP. The number of residents who had APs prescribed also statistically significantly increased (p=0.001) from CP (n=7, f=11) to AMP (n=19, f=55). There was a decrease in the number of residents (n=2, 7.4%) who had ED admissions from CP (f=45) to AMP (f=18). There was also a decrease in the number of residents (n=2, 7.4%) who had IP admissions from CP (f=40) to AMP (f=16). However, the total frequency of ED (p=0.454) and IP (p=0.607) admissions across each phase was not statistically significantly different (Table 2.6). The duration of IP admission stays across all patients decreased from CP (409 days) to AMP (65 days) and the IP mean days decreased from CP (10 days) to AMP (6 days). However, this decrease was not statistically significant. The results indicate that the increase in local monitoring resulted in statistically significant increases in GPV and AP which could have resulted in the decrease observed in ED and IP hospital admissions, IP total days and IP mean.

Table 2. 6: Frequency of Clinical Outcomes per Phase (n=27)

	CP(n=27)			AMP(n=27)			AMP vs CP			
	n	**%**	**f**	**n**	**%**	**f**	**n**	**%**	**f**	**p**
GPV	20	74.10	83	27	100	142	7	25.90	59	0.009
AP	7	25.90	11	19	70.4	55	12	44.40	44	<0.001
ED	15	55.60	45	13	48.1	18	-2	-11.10	-28	0.454
IP	13	48.10	40	11	40.7	16	-2	-11.10	-25	0.607
IP Total	409 days			65 days						
IP Mean	10 days			6 days						

CP=Control Phase, AMP=Active Monitoring Phase, GPV=General Practitioner Visits, AP=Antibiotic Prescribed, ED=Emergency Department Admission, IP=Inpatient Admission, n=number of residents, f=frequency of clinical outcome, f/n=outcome frequency per number of residents, p= p-value.

Table 2.7 shows the number of clinical outcomes during CP, AMP and AMTAP (n=14). Whilst the number of GPVs received by residents was similar during CP (n=10, f=54) and AMP (n=14, f=52), there was an increase in GPVs during AMTAP (n=14, f=65) of which only 31 (47.7%) of the GPVs were due to text alerts whilst the remaining 34 (52.3%) GPVs were routine consultations. The increase observed in GPV was not statistically significant (p= 0.09). The text alerts prompted 63.1% (n=41/65) of GP visits during AMTAP. The number of APs prescribed for residents increased from CP (n=1, f=3) to AMP (n=7, f=9) and increased further during AMTAP (n=7, f=20), with the latter increase being statistically significant (p= 0.031). Although the number of APs prescribed for residents increased from CP (n=1, f=3) to AMP (n=7, f=9) and increased further during AMTAP (n=7, f=20), with the latter increase being statistically significant (p= 0.031). Only eight events (40%) of APs being prescribed during AMTAP were due to text alerts but represented 90% (n=18/20) of the total amount of antibiotics prescribed. The decrease in ED from CP (n=7, f=22) to AMP (n=5, f=7, p=1) and to AMTAP (n=7, f=10,p=1) was not significant. Similarly, the decrease in IP from CP (n=7, f=21) to AMP (n=4, f=6, p=0.219) and to AMTAP (n=7, f=10,p=0.453) was not significant. Unfortunately, no text alerts prompted an ED or IP. It must be noted that the system was offline on three occasions during AMTAP. All ED admissions during AMTAP resulted in IP admissions and whilst both the total IP days (251 vs 16 days) and IP mean days (35 vs 3 days) decreased from CP to AMP, they were slightly increased in total (47 days) and mean (5 days) during AMTAP, but still they were lower than CP.

*Table 2. 7: Frequency of Clinical Outcomes per Phase (n=14)**

Final Outcomes	CP(n=14)			AMP(n=14)			AMTAP (n=14)			AMP vs CP				AMTAP vs CP			
	n	%	f	n	%	f	n	%	f	n	%	f	p	n	%	f	p
GPV	10	7.1	54	14	100	52	14	100	65	4	28.6	-2	0.291	4	28.6	11	0.09
AP	1	7.1	3	7	50	9	7	50	20	6	42.9	6	0.063	6	42.9	17	0.031
ED	7	50	21	5	36	7	7	50	10	-3	21.4	-15	0.453	0	0	-11	1
IP	7	50	21	4	29	6	7	50	10	-4	28.6	-16	0.219	0	0	-11	1
TA	0	0	0	0	0	0	14	100	136	0	0	0	N/A	14	100	136	N/A
RR	0	0	0	0	0	0	13	93	51	0	0	0	N/A	13	92.9	52	N/A
IP Total	251 days			16 days			47 days										
IP Mean	35 days			3 days			5 days										
Total number of GP Visits due Text Alerts							31										
Total number of Antibiotics prescribed due to Text Alerts							18										
Frequency of Antibiotics prescribed due to Text Alerts							8										

*CP=Control Phase, AMP=Active Monitoring Phase, AMTAP=Active Monitoring with Text Alerts, GPV=General Practitioner Visits, AP=Antibiotic Prescribed, ED=Emergency Department Admission, IP=Inpatient Admission, IPT= Total Inpatient Days, IPM= Mean Inpatient Days, TA=Text Alert, RR=Rapid Response, n=number of residents and f=frequency of clinical outcome, f/n= f/n=outcome frequency per resident, p= p-value, N/A= Not Applicable

2.4.4. Reasons for Hospital Admissions

Table 2.8 shows that there was a decrease in admission for asphyxia (3→0), falls (16→1), oedema (1→0), pneumonia (3→2), seizures (6→2) and unitary tract infections (7→5) from CP to AMP. There was an increase in constipation (0→1), dehydration (0→1), hypoglycaemia (0→2) and suspected cerebrovascular accident (CVA) (0→2). Whist no significant differences in admission reasons have been reported since the implementation of THS, it is worthy to note that there were decreases in admissions in three preventable conditions, that is, falls, urinary and respiratory tract infections.

*Table 2. 8: Reasons for Admission (n=27)**

Admission Reason	CP		AMP		AMP vs. CP (n=27)		
	n	f	n	f	n	f	p-value
Asphyxia	1	3	0	0	3	3	1
Constipation	0	0	1	1	-1	-1	1
Dehydration	0	0	1	1	-1	-1	1
Falls	3	16	1	1	15	15	0.625
Hypoglycaemia	0	0	1	2	-2	-2	1
Oedema	1	1	0	0	1	1	1
Pneumonia	2	3	2	2	1	1	1
Seizures	3	6	1	2	4	4	0.625
Skin Inflammation	1	4	0	0	4	4	1
Suspected CVA	0	0	2	2	-2	-2	0.5
Urinary Tract Infection	2	7	2	5	2	2	1
Total	**13**	**40**	**11**	**16**			

*CP=Control Phase, AMP=Active Monitoring Phase, , n= Number of Residents and f= Frequency of Clinical Outcome

Table 2.9 shows the relationship between co-morbidity/medical history and reason for hospital admissions in during CP and AMP. There was a strong positive correlation between having type 2 diabetes and being admitted for hypoglycaemia during AMP (not CP) which was statistically significant ($\tau b = 0.693$, $p<0.001$). There was a moderate positive correlation between having arthritis/osteoarthritis and being admitted for a fall during CP (not AMP) which was statistically significant ($\tau b = 0.489$, $p=0.011$). There was

a moderate positive correlation between having a history of CVA and being admitted for a CVA during AMP (not CP) which was statistically significant (τb = 0.4, p = 0.041).

*Table 2. 9: Co-Morbidities/Medical Condition History vs. Reason for Admission (n=27)**

Co-Morbidity or Medical History	Reason for Admission	CP Kendal-Tau (τb)	CP (p-value)	AMP Kendal-Tau (τb)	AMP (p-value)
Diabetes Type 2	Hypoglycaemia	0	1	0.693	<0.001
Arthritis/Osteoarthritis	Falls	0.489	0.011	0	1
CVA	Suspected CVA	0	1	0.4	0.041

***CP=Control Phase, AMP=Active Monitoring Phase**

Table 2.10 shows that there was a decrease in admissions for asphyxia (3→0), falls (5→4), oedema (1→0), seizures (6→1) and urinary tract infection (6→0) from CP to AMP. However, there was an increase in admissions for CVA (0→2) and hypoglycaemia (0→2). When comparing CP to AMTAP, there was an increase in admissions in skin inflammation (0→2), falls (5→6) and pneumonia (0→1) and a decrease in asphyxia (3→0), oedema (1→0), seizures (6→0) and urinary tract infection (6→1), Whist no significant differences in admission reasons have been reported since the implementation of THS, it is worthy to note that there were decreases in admissions during AMP in two preventable conditions, that is, falls and urinary tract infections. Unfortunately, the THS text alerts during AMTAP resulted in increases in admissions in two preventable conditions, that is, falls and pneumonia.

*Table 2. 10: Reasons for Admission (n=14)**

Admission Reason	CP		AMP		AMTAP		AMP vs. CP (n=14)			AMTAP vs. CP (n=14)		
	n	f	n	f	n	f	n	f	p-value	n	f	p-value
Asphyxia	1	3	0	0	0	0	3	3	1	1	3	1
Skin Inflammation	0	0	0	0	1	2	0	0	1	-1	-2	1
Falls	2	5	1	1	4	6	4	4	1	-2	-1	0.687
Oedema	1	1	0	0	0	0	1	1	1	1	1	1
Pneumonia	0	0	0	0	1	1	0	0	1	-1	-1	1
Hypoglycaemia	0	0	1	2	0	0	-2	-2	1	0	0	1
Seizures	2	6	1	1	0	0	5	5	0.5	2	6	0.5
Suspected CVA	0	0	2	2	0	0	-2	-2	0.5	0	0	1
Urinary Tract Infection	1	6	0	0	1	1	6	6	1	0	5	1
Total	**7**	**21**	**5**	**6**	**7**	**10**						

*CP=Control Phase, AMP=Active Monitoring Phase, AMTAP=Active Phase with Text Alerts , n= Number of Residents and f= Frequency of Clinical Outcome

Table 2.11 below shows the relationship between co-morbidity/medical history and reason for hospital admissions in related categories. There was a strong positive correlation between having arthritis/osteoarthritis and being admitted for a fall during CP (not AMP or AMTAP) which was statistically significant (τb = 0.68, p=0.012).

Table 2. 11: *Co-Morbidities/Medical Condition History vs. Reason for Admission (n=14)**

Co-morbidity or Medical History	Reason for Admission	CP Kendal-Tau (τb)	CP (p-value)	AMP Kendal-Tau (τb)	AMP (p-value)	AMTAP Kendal-Tau (τb)	AMTAP (p-value)
Arthritis/Osteoarthritis	Falls	0.68	0.012	0.372	0.18	0.18	0.503

*CP=Control Phase, AMP=Active Monitoring Phase, AMTAP=Active Monitoring with Text Alerts

2.4.5. Medicine Optimisation

Table 2.12 (n=27) shows that the largest statistically significant (p<0.001) effect of THS on medication changes was to add medication from CP (m=16) to AMP (m=54). The THS also resulted in a statistically significant (p<0.001) increase in medication changes in AL from CP (m=16) to AMP (m=68) and a decrease in medication changes in hospital from CP (m=26) to AMP (m=12). During AMP, there was a statistically significant (p<0.001) increase in the medication changes in AL versus hospital.

Table 2.13 (n=14) shows that the largest effect of THS on medication optimisation was to add medication during AMP with an increase of six and twenty-six medication during AMTAP respectively. The total number of medication changes was 32 in CP compared to 34 and 44 in AMP and AMTAP respectively. Whilst medication changes were higher in hospital than AL during CP (m=21 vs m=11), during the THS phases, medication changes were statistically significantly higher in AL than hospital during AMP (m=32 vs m=2, p=0.012) and AMTAP (m=39 vs m=35, p=0.031). During AMP (p=0.001) and AMTAP (p=0.016), there was a statistically significant increase in medication changes in AL versus hospital. During AMTAP, the THS with text alerts seemed to have had the largest total number of medication optimisation interventions (n=44) for residents. Even though the THS increased medicines changes, 30% (n=3) of admissions (f=10) were due to poor medication optimisation during AMTAP. Three examples of THS impacted medical optimisation is discussed below.

On the 15/7/17 (Sat), resident AL1 was transferred to the ED and admitted as an IP due to a bruised eye resulting from a fall. It was discovered that she was receiving suboptimal medication dosages resulting in seizures and the Hospital Consultant increased resident AL1's seizure medication dosage, that is, levetiracetam increased from 250mg to 500mg twice daily. Resident AL1 was discharged on the 17/7/17 to AL.

On the 18/04/2017, resident AL2 was found on the floor in bedroom and was limping on their left leg. The GP made a referral due to a DVT query resulting in a transfer to the ED and IP. The hospital consultant discovered that resident AL2 was dehydrated, had a lower respiratory tract infection (LRTI) and stopped the pain medication patch (buprenorphine patch) which causes drowsiness and respiratory depression.

Resident AL5 was taking lorazepam and was prescribed zopiclone 3.75mg on the 26/06/2017 to normalise sleep patterns as resident AL5 was restless at night and

walking in corridors presenting a risk of falls. Resident AL2 was found sitting on floor on the 30/06/2017. On the 31/07/2017 (Monday) resident AL5 was found with a bruise on forehead and skin tear on right knee resulting in hospital admission. On the 15/08/2017, GP amended the prescription to zopiclone 3.75mg prn at night and stopped the lorazepam tablets. Resident AL5 was referred to Falls clinic.

*Table 2. 12: Optimisation Medication per Phase (n=27)**

	CP (n=27)			AMP (n=27)			AMP vs CP			
	n	**m**	**m/n**	**n**	**m**	**m/n**	**n**	**m**	**m/n**	**p**
Increase Dose	4	4	1	1	1	1	-3	-3	1	0.375
Decrease Dose	2	3	1.5	3	4	1.3	1	1	1	1
Add Medication	8	16	2	22	54	2.5	14	38	2.7	<0.001
Stop Medication	10	19	1.9	12	18	1.5	2	-1	1	0.804
Replace Medication	0	0	0	2	3	1.5	2	3	1.5	0.5
Total	42			80			p=0.180			
Medication Changes in Hospital	26			12			p=1			
Medication Changes in Albany Lodge	16			68			P<0.001			
p-Value	0.302			<0.001						

*CP=Control Phase, AMP=Active Monitoring Phase, m=Number of Medication and n=Number of Residents

*Table 2. 13: Optimisation Medication per Phase (n=14) **

	CP (n=14)			AMP (n=14)			AMTAP (n=14)			AMP vs CP (n=14)				AMTAP vs CP (n=14)			
	n	**m**	**m/n**	**n**	**m**	**m/n**	**n**	**m**	**m/n**	**n**	**m**	**m/n**	**p**	**n**	**m**	**m/n**	**p**
Increase Dose	3	3	1	1	1	1	2	2	1	-2	-2	1	0.625	-1	-1	1	1
Decrease Dose	2	3	1.5	1	2	2	1	1	1	-1	-1	1	1	-1	-2	2	0.5
Add Medication	3	11	3.7	9	17	1.9	7	37	5.3	6	6	1	0.18	4	26	6.5	0.18
Stop Medication	7	15	2.1	6	11	1.8	3	4	1.3	-1	-4	4	1	-4	-11	2.8	0.125
Replace Medication	0	0	0	2	3	1.5	0	0	0	2	3	1.5	0.5	0	0	0	1
Total	32			34			44			p=0.655				p=0.317			
Medication Changes in Hospital	21			2			5			p=0.625				p=1			
Medication Changes in Albany Lodge	11			32			39			p=0.012				p=0.031			
p=Value	0.727			0.001			0.016										

*CP=Control Phase, AMP=Active Monitoring Phase, AMTAP=Active Monitoring with Text Alerts, m=Number of Medication and n=Number of Residents

Table 2.14 (n=27) shows that there was an increase (m=33, p=0.189) in total medication prescribed from CP (m=224, median=9, mode=6, minimum=1, maximum=17) to AMP (m=257, median=9, mode=9, minimum=2, maximum=18). There was a decrease in medication prescribed in the following categories from CP to AMP: nervous system (m=8, p=0.227), those with ARS-1 (m=6, p=0.508), ARS-3 (m=1, p=1), high risk (m=9, p=0.344) and high risk of falls (m=9, p=0.344). Interestingly, there was a statistically significant increase in medication prescribed in the following categories: antibiotics (m=44, p<0.001), ARS=0 (m=40, p=0.012), low risk (m=42, p=0.012), low falls risk (m=42, p=0.012). There was no change in the ARS-2 category. The THS resulted in more preventative medication being prescribed e.g. antibiotics and lower risk medication and medication with a lower anticholinergic risk and a lower risk of falls.

Table 2.15 (n=14) shows that there was a decrease in total medication prescribed in the following categories from CP (m=114, median=9, mode=10, minimum=3, maximum=13) to AMP (m=110, median=8, mode=9, minimum=3, maximum=13): total medication (m=4, p=0.754), nervous system (m=8, p=0.063), ARS-1 (m=7, p=0.375), high risk (m=8, p=0.375) and medication that has a high risk of causing falls (m=8, p=0.375). There was an increase in medication prescribed in the following categories from CP to AMP: antibiotics (m=6, p=0.125), ARS-0 (m=3, p=0.754), low risk medication (m=4, p=0.754) and medication with a low risk of causing falls (m=4, p=0.754). There was no change in ARS-2 and ARS-3 medication from CP to AMP. There was an increase in medication prescribed from CP (m=114, median=9, mode=10, minimum=3, maximum=13) to AMTAP (m=135, median=8, mode=5, minimum=4, maximum=16) in the following categories: total medication (m=11, p=0.227), antibiotics (m=17, p=0.125), ARS-0 (m=16, p=0.109), low risk (m=17, p=0.227) and medication with a low risk of causing falls (m=18, p=0.227). There was a decrease in medication prescribed in the following categories from CP to AMTAP: nervous system (m=7, p=0.219), ARS-1 (m=5, p=0.375), ARS-2 (m=1, p=1), ARS-3 (m=1, p=1), high risk medication (m=8, p=1) and medication with a high risk of causing falls (m=9, p=0.687). The THS with text alerts had a greater effect on reducing the prescribing of medication with a higher anticholinergic scale, higher risk medication that causes falls whilst promoting the prescribing of preventative medication e.g. antibiotics and safer medication, ARS-0 medication and medication with a lower risk of causing falls.

*Table 2. 14: Classification of Medication per Phase (n=27)**

	CP	AMP	CP vs. AMP	
	m	m	m	p-value
Total Meds	224	257	33	0.189
Nervous System Medication	63	55	-8	0.227
Antibiotic Medication	11	55	44	<0.001
Medications with ARS-0*	173	213	40	0.012
Medications with ARS-1*	41	35	-6	0.508
Medications with ARS-2*	3	3	0	1
Medications with ARS-3*	7	6	-1	1
High Risk Medication	79	70	-9	0.344
Low Risk Medication	145	187	42	0.012
High Falls Risk Medication	77	68	-9	0.344
Low Falls Risk Medication	147	189	42	0.012
Median	9	9		
Mode	6	9		
Minimum	1	2		
Maximum	17	18		

*ARS= Anticholinergic Risk Scale, CP=Control Phase, AMP=Active Monitoring Phase, m=number of medication

*Table 2. 15: Classification of Medication per Phase (n=14)**

	CP (n=14)	AMP (n=14)	AMTAP (n=14)	CP vs. AMP		CP vs. AMTAP	
	m	m	m	m	p-value	m	p-value
Total Meds	114	110	125	-4	0.754	11	0.227
Nervous System Medication	35	27	28	-8	0.063	-7	0.219
Antibiotic Medication	3	9	20	6	0.125	17	0.125
Medication with ARS-0*	83	86	99	3	0.754	16	0.109
Medication with ARS-1*	24	17	19	-7	0.375	-5	0.375
Medication with ARS-2*	2	2	1	0	1	-1	1
Medication with ARS-3*	5	5	4	0	1	-1	1
High Risk Medication	46	38	38	-8	0.375	-8	1
Low Risk Medication	68	72	85	4	0.754	17	0.227
High Falls Risk Medication	46	38	37	-8	0.375	-9	0.687
Low Falls Risk Medication	68	72	86	4	0.754	18	0.227
Median	9	8	8				
Mode	10	9	5				
Minimum	3	3	4				
Maximum	13	13	16				

***ARS= Anticholinergic Risk Scale, CP=Control Phase, AMP=Active Monitoring Phase, AMTAP=Active Monitoring with Text Alerts, m=number of medication**

Following on from the analysis above, the CPS score for the residents was calculated. Table 2.16 shows that the mean and mode CPS of the residents for the three phases of the study were similar to each other with most residents falling into the moderate followed by severe risk categories. It is important to note that 4 residents passed away during the AMP and 2 residents passed on during the AMTAP.

Table 2. 16: CPS Scores

CPS* Category	CPS Score				
	CP (n=27)	**AMP (n= 27)**	**CP (n=14)**	**AMP (n=14)**	**AMTAP (n=14)**
Mild n (%)	3 (11.1)	4 (14.8)	1 (7.1)	1 (7.1)	1 (7.1)
Moderate n (%)	16 (59.3)	15 (55.6)	9 (64.3)	9 (64.3)	8 (57.1)
Severe n (%)	7 (25.9)	6 (22.2)	4 (28.6)	4 (28.6)	3 (21.4)
Morbid n (%)	1 (3.7)	2 (7.4)	0 (0)	0 (0)	2 (14.3)
Mean CPS	12.5	13.2	12.7	12.6	13.1
Median CPS	5	5	2.5	2.5	2.5
Mode	10	10	10	10	11
Max	22	24	4.3	4.7	23
Min	4	4	21	21	4

*CP=Control Phase, AMP=Active Monitoring Phase, AMTAP=Active Monitoring with Text Alerts. * CPS score categories: mild (0-7), moderate (8-14), severe (15-21) and morbid (≥ 22).

Table 2.17 shows the frequency of admission related to falls in each phase. IP admissions related to falls decreased from 16→1 (n=27) and 5→1 (n=14), resulting in a relative risk reduction (RRR) during AMP of [(n=27,93.8%), (n=14, RRR=80%)] and an odds ratio (OR) during AMP of [(n=27, OR=0.0625, 95% confidence interval 0.0077 to 0.5051, p=0.0093), (n=14, OR=1.2, 95% confidence interval 0.2962 to 4.8617, p=0.7984)], thus the odds of having a fall during AMP (n=27) was nearly 99.9% less than in CP, however the odds of a fall was not different from CP when the comparison was conducted for the 14 patients. The THS improved the awareness of staff and prescribers at AL resulting in fewer centrally acting sedating medication being prescribed and this could have contributed to the reduced number of hospital admissions due to falls during AMP. However, during AMTAP, the THS text alerts transferred clinical autonomy and accountability from the HCPs at AL (local) to the RRT

(remote) resulting in the higher number and frequency of falls in AL and hospital admissions for falls.

Table 2. 17: Falls per Phase

	CP (n=27)	AMP (n= 27)	CP (n=14)	AMP (n=14)	AMTAP (n=14)
nr (%)	8 (29.6)	3 (11.1)	3 (21.4)	3 (21.4)	6 (42.9)
ff (%)	11 (30.6)	5 (13.9)	3 (21.4)	4 (28.6)	20 (55.6)
fr (%)	15 (55.6)	15 (55.6)	7 (50)	7 (50)	7 (50)
nh (%)	4 (14.8)	2 (7.4)	3 (21.4)	1 (7.1)	4 (28.6)
fh (%)	16	1	5	1	6

CP=Control Phase, AMP=Active Monitoring Phase, AMTAP=Active Monitoring with Text Alerts, nr= Number of Residents recorded on Albany Falls Register, ff=Frequency of falls recorded on Albany Falls Register, fr=Frequency of Residents with a history of falls, nh=Number of Residents admitted to hospital due to a fall and fh= Frequency of hospital admissions due to a fall.

2.5. Qualitative Results

2.5.1. HCPs Interviewed

Participants were approached before AMP and after the AMTAP to invite them to be interviewed. Six doctors were interviewed of which five were resident GPs of AL and one was the Croydon Community Geriatrician. Within AL, the manager, nurses, and carers were interviewed. The Croydon RRT consisting of two nurses and the nurse manager and two paramedics that frequently respond to AL were also interviewed. The Head of Community Nursing was also interviewed after AMTAP. A summary of the interviewees is provided in Table 2.18. Analysis of the interviews revealed the following TH themes before implementation: knowledge, barriers, goals and beliefs, environmental context and resources, professional role identity and emotions and optimism. Analysis of interviews after AMTAP, revealed the following new themes in addition to the above themes: memory and reinforcement, behavioural regulation, and future intentions. Pre and post themes supported by HCP quotations are discussed below.

Table 2. 18: Summary of Interviewees

Participant	Code used for citing their quotations	n (Pre-AMP)	n (Post-AMTAP)
Doctors	D	6	6
Albany Manager	AM	1	1
Albany Nurse	AN	2	2
Albany Carers	AC	20	14
Rapid Response Nurse	RRN	2	2
Rapid Response Management	RRM	1	1
Paramedic	P	2	2
Head of Community Nursing	HCN	0	1
Total		33	28

2.5.2. Pre-TH Interview Analysis

Theme 1: Knowledge, Awareness and Understanding of TH

Most HCPs, excluding the AL team and one doctor, reported having knowledge, awareness and understanding of TH. HCPs reported that previous experiences with TH were positive where a THS containing a camera supported the assessment and diagnosis of unwell patients.

"In the beginning I didn't have a clue regarding TH." ***(AN1)***

"It was okay. I mean the patient has to be motivated. It worked well." ***(D2)***

"My past experience of TH has been very positive." ***(RRN2)***

"We have used it in my practice before for blood pressure monitoring." ***(D2)***

"Very little, they couldn't assess/recognise a sick patient, so they found that by looking at a patient on a camera it was very useful for you to know if they were sick or not." ***(D1)***

"Remote monitoring and a remote way of being able to assess residents." ***(D4)***

Theme 2: Perceived Barriers of TH

The interviews highlighted HCPs perceived barriers of successful TH implementation. Whilst AL nurses and carers expected an increase in workload due to the daily job time constraints, doctors were concerned about the lack of suitability trained staff and the increase in carer stress and anxiety due to the THS as a barrier to successful THS implementation. Management was concerned that the THS will isolate residents from HCPs whilst paramedics were concerned about the lack of management support to ensure that staff are adequately trained to use the THS. Concerns around expected barriers were not discussed in the pre-implementation training.

"I think it all is going to depend on the workload of the day" ***(AC1)***

"I have to find time to do TH" ***(AN1)***

"I think that one of the issues that always is a problem here is shortage of trained staff" ***(D4)***

"I would be concerned about getting more calls because it may increase anxiety amongst staff actually" ***(D4)***

"It will keep the GPs away from their residents" ***(RRM)***

"Management have to ensure that the right team are consistent in using the equipment" ***(P2)***

Theme 3: Goals and Beliefs about Consequences

It is interesting that even though AL management reported that AL had been previously penalised due to a failure to seek medical advice within an appropriate time, a RRT nurse reported that AL HCPs were afraid of being accused of contacting emergency services unnecessarily and that this fear could result in residents not getting the appropriate level of care promptly. This created a blame culture in AL and unfortunately, the value of the THS to help resolve current beliefs was not discussed at the pre-implementation training e.g. the ability of TH to empower HCPs.

"We had been penalised for a delay in seeking of medical advice. So, I think that TH will help me with this weakness" ***(AM)***

"Some people are scared to ring 999 because they have been told that they are ringing too much so sometime there is a risk of not ringing the appropriate service when it is needed" ***(RRN1)***

AL nurses and doctors reported that their beliefs and expected goals of TH implementation included an increased awareness of the need for monitoring and improved work efficiency and job satisfaction.

"*We will be more responsive to people who are deteriorating and become acutely unwell"* ***(D1)***

"We can get the results so quickly. We'll be able to do our work faster" ***(AC)***

Theme 4: Environmental Context and Resources

RRT nurses and paramedics reported that TH is suitable for implementation in AL due to a high rate of unplanned emergency hospital admissions of residents and is suitable

for residents with dementia as they may find it difficult to communicate changes in health status when unwell.

"I think that it will be a good thing to start up because AL has high increase of residents going into hospital." ***(RRN2)***

"Residents with dementia especially, they not as good as communicating certain things, if they in pain or if they got a temperature." ***(P1)***

Doctors questioned the suitability of TH to support the dementia environment e.g. both the short-term and long-term care needs of residents with dementia underpinned by the irreversibly declining nature of the disease. They also questioned the cost efficiency of the THS to record vital signs as compared to standard care techniques.

"Most dementia residents, unless they have other chronic diseases, probably won't have many problems until they get to the end of life. So, I don't know what the value would be in dementia?" ***(D2)***

"I am not sure if TH is any particular advantage because I would hope that they would see a decline in the patient anyway." ***(D4)***

"I am not so sure that it will be particularly useful for infection because if they were normal before, it's not going to help you because know they are tachycardiac and hypertensive." ***(D2)***

"How much money do you want to spend just for the reading? Value for money exercise." ***(D6)***

AL nurses reported that residents with dementia are not comfortable using the blood pressure cuff whilst a doctor indicated that there is an issue with the reliability of testing of vital signs at AL. The THS included a blood pressure cuff and the concerns raised below questioned the suitability of the resources provided to the environment, that is, dementia friendly equipment is needed to complete monitoring tasks successfully.

"It is difficult to use the machine in dementia residents because of the confusion. I have tried, as soon as you apply the cuff, they just want to take it off." ***(AN2)***

"There is the obvious issue with the reliability of the testing." ***(D1)***

Doctors reported that the implementation of the THS would not change their response to unwell residents e.g. physically examining the residents during a home visit and hence questioned the value contribution of THS in the care of residents with dementia.

"It wouldn't make any difference because if they ask me to do a home visit, my duty of care means I still have to do the home visit." ***(D2)***

"I can't base it just on numbers, I have to treat the patient and not the numbers." ***(D1)***

Theme 5: Identification of Professional Role

HCPs had mixed views on the impact of the THS on their professional role. Some HCPs reported that they expected that the THS will enhance their professional role through improved clinical decision making, faster response time and increased professional communication and thus reduce hospital admissions whilst others were concerned that TH would reduce professional skills.

"We can ring/phone the consultant with the data and ask for a possible diagnosis" ***(RRN1)***

"Having the system, the more information you have, then it helps the clinician to make a decision about it" ***(RRN2)***

"My hope is that it is doing part of my job, prevention of admission" ***(RRN2)***

"I guess it is more supportive for the staff and maybe a quicker response for residents" ***(P1)***

"We are de-skilling nurses" ***(RRN1)***

2.5.3. Post-TH Interview Analysis:

HCPs reported various themes and subthemes during the post TH implementation interviews. Whilst similar themes of barriers, goals and beliefs, environmental context and resources and professional role emerged in both the pre and post implementation interviews, the themes of emotion and optimism, memory and re-enforcement, behavioural regulation and future intentions emerged only in the post interviews.

Theme 1: Knowledge, Awareness and Understanding of TH

Doctors reported no changes in their knowledge, awareness and understanding of TH and its impact on the treatment pathway. The AL carers and RRNs that did receive the THS pre-implementation training reported an increased knowledge, awareness and understanding of TH. AL carers that were not invited to the THS pre-implementation training reported being unaware of the THS and the rationale of its use. Thus this resulted in varying levels of knowledge, awareness and understanding of TH amongst staff.

"I don't think that my understanding of the TH has changed much as we used to have a similar system at the surgery some time ago" ***(D3)***

"When you ring up, actually the carers have either repeated the observation or acted upon them and actually there isn't a lot to be done" ***(D1)***

"My understanding of TH has changed" ***(AC8)***

"My experience of TH at AL has been completely different" ***(RRN1)***

"Some of the staff don't know the purpose of the THS. Why are we only using it on one floor, that is, a dementia floor?" ***(AC7)***

"I don't think all the staff at AL understand much about TH" ***(RRN2)***

Theme 2: Barriers to TH Implementation

It is interesting that similar barriers in both the pre and post TH implementation interviews were reported including lack of GP and management support, inadequate staff and inadequate training. AL HCPs also reported additional barriers to successful TH implementation under various subthemes during the post TH interviews: poor communication, equipment failure, poor recruitment of participants and poor implementation for example the lack of THS pre-implementation training for the night nurses was reported as a barrier to successful TH implementation.

Poor communication was reported by RRT nurses, RRT management and doctors as a barrier to successful implementation of TH and included: no feedback on the performance of TH during the three study phases to all HCPs, no confirmation that text messages had been successfully delivered to RRT and an uncertainty of residents' awareness of participation in the study.

"Some of the people don't know what it is about. The night nurses don't know anything" ***(RRN2)***

"The THS has not been discussed in meeting to say that this system is working brilliantly" ***(AC1)***

"The team has not liaised with me regarding use of TH. There was no follow up to update us on the challenges experienced in implementation" ***(D6)***

"You get told that you are obviously getting it, but you are not picking them up and people were disbelieving the fact that we were not getting them until it was discovered that we were not getting them. That is disappointing for a pilot" ***(RRM)***

*"I am not sure if the residents understood if they were a part of it" (**RRM)***

Equipment failure was reported by all HCPs and management as a major barrier to successful implementation of TH including: not receiving text alerts, unnecessary text alerts, inaccurate equipment resulting in inaccurate readings and thus having to repeat vital signs measurements using manual equipment and the THS only able to record one type of vital sign measurement at a time requiring a longer time to take vital signs compared to standard care. Lack of system support from Croydon Equipment Solutions was also reported as a barrier to implementation.

"I think that it has potential, but it was flawed in some areas e.g. getting alerts through and the equipment not working at the end was not great particularly when you get an alert and someone's saturation levels were 66%. Then you think if they are 66% then we have a problem here and then they should they be sitting in a home instead of a hospital? If they were 66%, we would have to go out" ***(RRM)***

"In some cases, we ring up and their blood pressure is always a bit low. I would perhaps ensure that the equipment is robust and being calibrated and having parameters for individual residents" ***(D1)***

"It seemed a bit hit and miss at times e.g. machinery did not work" ***(P1)***

"My other concern is that when I used the machine to take the readings, it took too long to take the readings" ***(AN1)***

"Making sure that the system wasn't faulty" ***(RRN1)***

"What we found at the end was that they were having to do a set of observations twice because the equipment was not working" ***(RRM)***

"I didn't feel that we had enough system support initially." ***(AM)***

Inadequate staff was reported by both management and HCPs as a barrier to successful TH implementation and included the following reasons: high turnover of staff resulting in untrained staff and not enough additional staff allocated to cover the duties during TH testing days. The THS required extra staff as the allocated time frames to take vital sign measurements that clashed with other priorities e.g. residents lunch time. Furthermore, additional human resource funding was not allocated to the HCN thus resulting in feelings of stress and anxiety.

"This care home has a high turnover of staff; I don't think that that will ever go away" ***(P1)***

"On the day that TH readings need to be taken, especially on the dementia floor, an extra staff member is required to assist as it is a busy floor and we have to protect the residents that walk in the corridor" ***(AC11)***

"The additional work is that sometimes it came through quite late and obviously we get quite busy towards the end of the day. That was a little bit tedious and we have said it doesn't work for us" ***(RRM)***

"Sometimes with the workload, staff can't take the readings within the 10am to 2pm slot including their lunch time" ***(AM)***

"Sometimes you are the only one on the floor and you are so busy, but you still have to do TH within the time frame" ***(AN2)***

"I have been given this project on top of my usual day work but acknowledging that I have no additional time to do it and no additional funding has been granted to do that" ***(HCN)***

The lack of GP support was also reported by RRT nurses and HCN as a barrier to TH implementation. However, GPs reported that they felt excluded from the TH implementation due to lack of training, communication and feedback. The lack of management support was also reported as a major barrier to successful implementation and included a failure to attend meetings, the retiring of the PI and a time lapse of 2 months during the study until the CN was allocated the role.

"There is also the challenge of getting the GPs on-board. If we get some alerts, what are they going to do about it? Are they interested?" ***(CN)***

"Where do you draw the line? We left that with the GP to decide when to act on it, but nothing happened" ***(RRN2)***

"It became an AL project rather than a GP-AL project" ***(D6)***

"There have been a few times that I have turned up and management have not been able to meet me" ***(HCN)***

"The person that was leading on it retired and there was a limbo land" ***(RRN2)***

Poor recruitment of participants was reported by HCPs as a major barrier to successful TH implementation and included poor selection of residents as AL staff reported that they were not asked for their advice during participants' recruitment and selection process. This resulted in some of the residents selected being resistant to the use of TH e.g. moving hands so that a blood pressure reading would be inaccurate and therefore would generate unnecessary text alerts. Whilst consulting nurses and purposive sampling is supportive of study design and participant recruitment (see section 2.3.4.), the investigators needed to ensure that the inclusion and exclusion criteria is strictly applied to participant selection to avoid lack of persistence in the study affecting study

outcomes. In addition, physical illustration of the use of the monitoring devices rather than just verbal explanations, may have helped residents fully appreciate what the measurements entail and the frequency to confirm their willingness to take part and the timing of the day they prefer the measurements to be taken.

"It's about finding the right people, so I won't have thought the residents chosen were that appropriate. It might have been nice for staff to actually choose the residents. Residents need to be reviewed. We didn't know who was reviewing the residents" ***(RRM)***

"I think that we should use TH for dementia residents, but we need to select the residents that are more co-operative. If you ask the nurses, they will ask you tell you who is not co-operative, and it will be blank for their monitoring. Non-cooperative residents also will take more nursing time to take vital observations. This will be helpful for nurses and residents" ***(RRN1)***

"We have seen resistance to using TH equipment on our Rapid Response sheets where it states that patient refused" ***(D1)***

"They will be moving their hands, so we won't get accurate readings" ***(AN1)***

Poor implementation was reported as a major barrier to TH implementation and included: rapid implementation with inadequate training, lack of support and poor handover resulting in HCPs feeling insulted and forced to use TH and therefore resenting management. Other aspects of poor management included the poor THS customisation of each residents' vital sign parameters as AL staff were not consulted during system implementation resulting in unnecessary text alerts to RRT, late transmission of text alerts to RRT due to late docking of the THS in AL after use, lack of use of THS results from AL and RRT HCPs in clinical handover to external HCPs e.g. paramedics and GPs, poor time allocation of TH activities that was not suitable for both residents and HCPs. Some residents were reported to be confused and agitated in the morning and therefore taking TH vital sign monitoring readings in the morning resulted in unnecessary text alerts to RRT and thus HCPs reported that the THS needed to be implemented with more flexibility to support the current care practice standard. Nevertheless, the lack of personalised TH parameters and the resultant unnecessary text alerts increased awareness to the individual resident parameters and potentially optimised person-centred care.

"Having been told a week before that you are doing it, when you didn't know what was happening. I think that it was insulting to the staff." ***(RRM)***

"My question to whoever set the parameters is what is low that we should be getting worried?" ***(RRM)***

"That was the problem that we had so when it was initially set up, we were not given access to the parameters." ***(RRN1)***

"Because they were not docking it properly, we were then not getting the readings until the following day." ***(RRN1)***

"I have not heard the crew speak of it either, so I don't know if when an ambulance is requested whether the crews are being updated with the information from the THS." ***(P1)***

"I have not had any feedback where a nurse at AL had used TH and contacted me because of some finding that they had discovered and needed my expertise." ***(D6)***

"We need to be more flexible about the times that the readings are taken." ***(CN)***

"I think that it is difficult because the residents were on the dementia floor. A lot of their readings were when they were agitated, and it was not the right time of the day and it was difficult and that is difficult to manage." ***(RRM)***

Whilst AL management reported that the *level of training* was adequate, all HCPs reported that the level of training provided was inadequate and hence a barrier to implementation. No training was offered to new and night AL staff and GPs both before and during the study. The RRT reported a major barrier to implementation was that not all AL staff had received the same level of training and both AL carers and nurses reported that the training was not only inadequate but also not provided to all staff. The lack of training on the use of TH equipment resulted in improper system use and delays in responses e.g. poor docking of the system resulted in delayed text alert transmission and a dead battery causing more delays when needed for subsequent use.

"For my team, the training was fine. If you include too much information, it becomes confusing for them" ***(AM)***

“I don’t think that I have had any specific training and I have not had a follow up or ongoing training. In-between there has been a large void” ***(D6)***

“AL has a high staff turnover and new staff need to be trained or the machine will not be used” ***(D6)***

“The initial training provided was not adequate” ***(RRN2)***

“They have got a lot of staff and I don’t know if everybody had got the same training” ***(RRM)***

“If only one person knows how to use the system and if it is that person’s day off, then there will be trouble” ***(AC11)***

“When it first started, it would have been best to ensure that the staff knew what they were doing” ***(RRN1)***

Theme 3: Goals and Beliefs of TH

In both the pre and post interviews, HCPs reported subthemes goals of improved clinical effectiveness and efficiency. However, in the post TH interviews, HCPs reported new subthemes including beliefs of less workload than expected and inadequate clinical effectiveness after using the THS.

Management and some HCPs reported that the THS *improved clinical effectiveness* by offering residents an improved clinical response to a change in their health status and higher quality service levels by tracking vital sign trends which was not possible previously as vital signs were only recorded monthly. The THS also indirectly prompted increased support from GPs which was previously reported as a barrier to implementation. The quote below (AC11) highlighted the ability of the THS to change the healthcare from reactive to pro-active.

"There was a carer who used the THS just before the doctor did his rounds and the system detected that the resident's blood pressure was a bit high and this was brought to the attention of the doctor and dealt with" ***(AC11)***

"The THS had an impact on the residents because it picked up that some readings were a pattern and not a once off reading as we took the readings weekly e.g., we had one resident who had consistently low blood pressure and pulse" ***(AN2)***

"I think that TH improved the service levels at AL" ***(RRN2)***

"We would have not been doing the vital stats every week but rather once a month. The THS makes us monitor the vitals weekly, rather than monthly" ***(AN2)***

Improved clinical efficiency using the THS was reported by AL nurses and carers due to the THS making them monitor vital signs more regularly and therefore being faster in identifying changes and sharing the results with residents' GPs and RRT to facilitate immediate decisions. This enabled the staff to respond faster to the healthcare needs of residents.

"TH should be a priority for dementia residents as they are not able to express when they are unwell so if you are monitoring them regularly, you can easily identify any changes in their condition. Otherwise, we will only identify it in the last stage whereas with TH, we can identify a change in health status in the first stage. I think that THS

helps us to pick up the initial signs so that we can give appropriate treatment or support for them. It was really helpful for that" ***(AN1)***

"The THS was helpful if someone was not feeling well and we could get a quick recommendation rather than waiting for a doctor to come in and examine that patient and go away, make up a prescription and then we have to go and collect the prescription. This is a quicker way of diagnosing someone" ***(AC4)***

Whilst RRT and AL nurses reported increased anxiety and stress during the pre-TH implementation interviews due to an anticipated increase in workload, both RRT and AL nurses reported post TH implementation that the workload was much less than expected.

"It reduces the work of the AL nurse and RRT as it gives more support to each other" ***(AN1)***

"I was concerned that I will have enough time to use the THS. When I started using the system, 80% of my fears did not come true" ***(AN2)***

"We were told that Rapid was doing this and that it would be extra work. We expected to be far busier than we were" ***(RRN1)***

"I did think that there would be an increased workload but there were hardly any residents being monitored" ***(D5)***

Inadequate clinical effectiveness was interestingly reported by the HCN, doctors and paramedics due to multifactorial reasons including poor implementation (as discussed above), no change in the clinical management of unwell residents and no support or impact on doctors and paramedics. However, one doctor suggested that TH might have prompted a change in culture at AL even though TH had no clinical impact on the care of residents.

"I felt from the very beginning that implementing TH in this way would have very little benefit" ***(HCN)***

"I don't think that TH has had a big impact on anything or prompted any different care unless by the presence of the processes, they are being more facetious with their internal processes" ***(D1)***

"I could not allocate a change in call rates to TH" ***(P1)***

"I don't know if it has promoted a culture change at AL, but I am not aware of any cases that have had changes to their clinical care based on TH" ***(D1)***

Theme 4: Environmental Context and Resources

Inadequate clinical alignment of TH within the care pathway was reported as a major theme by the HCN, doctors, RRT nurses and RRT management. This theme was underpinned by the following: failure to integrate TH within the standard care management plans, the clinical inadequacy of weekly vital sign measurement, TH being more impactful in a non-nursing home, lack of clear implementation guidelines and system access for GPs, RRT and paramedics was considered as a major failing and poor organisational implementation resulting in professional conflict, that is, AL nurses were expected to report to RRT nurses.

"Are we going to link TH with the clinical management plan or a patient specific protocol?" ***(HCN)***

"A once off observation once a week is very difficult to interpret without having any further information about the resident or the trend of those observations" ***(D1)***

"I can see the value of TH in residential care homes and private homes but not at AL as they have good nurses" ***(RRM)***

"Rapid Response needs clear guidelines of what functions are expected to be conducted during a response e.g. a phone call or a visit. The GP needs to be available during pre-allocated times e.g. an hour slot once a week to review all the data and formulate a picture of what's going on" ***(RRN2)***

"They had the parameters there which is fine but perhaps we could have had a bit more access. That would probably have been better" ***(RRN1)***

"I think that it is difficult for nurses in a care home who have just taken a set of observations to have another nurse ring up and say we have noticed that this set of observations is a bit lower today" ***(RRM)***

Equipment suitability was reported by management, doctors and RRT nurses as a major resource limitation, that is, equipment was not dementia-friendly due to: health

screening questions being unsuitable for residents with dementia as their condition fluctuates during the day, residents with dementia being resistant to using the blood pressure cuff and weighing scale and this presented challenging behaviours and regular calibration and quality control of the equipment was needed to be conducted to ensure that it is suitable for use for residents with dementia e.g. ensuring the provision of thermometer probe covers.

"The questions can't be applied because the health status of the residents' changes from the time that you are taking the reading to later. The response to the questions asked in the morning will be different to the responses in the afternoon for dementia residents" ***(AM)***

"The residents are elderly and suffer from dementia so they may be resistance to a blood pressure check, an examination or receiving medication" ***(D6)***

"The equipment that we are using need to be updated. There needs to be consistent monthly quality control checks on the machine. The equipment needs to be fit for purpose and ensure that everyone knows how to use it. The probe covers for the thermometer needs to be available" ***(RRN2)***

Some AL HCPs reported some difficulty in using the equipment including ease of access, complexity of the system and that the system is limited as it is only able to take one type of vital sign measurement at the same time whereas two vital signs can be measured at the same time using manual equipment.

"Sometimes it doesn't come on, there is a password. You must scan the card and sometimes that doesn't work. Once we got it going, it is fine" ***(AC8)***

"I enjoyed using the THS. I found it difficult initially and it is so computerised, and I took a long time to learn it" ***(AC14)***

"Initially the THS was difficult to use because the machine took a long time for the reading. When taking blood pressure readings, I couldn't take the temperature at the same time. I had to wait for the blood pressure vital readings to complete be taken before I could take the temperature. If I take the readings manually, I can take the

temperature, pulse and blood pressure at the same time and enter the readings manually" ***(AN1)***

Theme 5: Professional Role and Identity

HCPs reported similar subthemes in both the pre and post TH implementation interviews including loss of professional skill, improved HCP relationships and improved professional role.

Whilst *loss of professional skill* was reported as a concern in both the pre and post TH implementation interviews, both the AL HCPs and the external HCPs reported that the AL HCPs improved their professional skills through supporting and educating each other over the period of the study resulting in an enhanced professional role and job satisfaction.

"We don't want TH to result in HCPs becoming reliant on what the machine tells you but to help improve in their knowledge and prompt them so that they see a change in resident's demeanour before they have even done the observations" ***(P1)***

"The personal impact that the THS has on my job is that I was able to use the system to teach the healthcare assistants and activity co-ordinators how to take observations. They have felt that they have learned something new through me" ***(AN2)***

"We feel more involved. We feel like we are a part of AL nursing team. If somebody ask you to take the observations and you can do it, you feel good and you feel confident that you can do something, and it helps the residents" ***(AC11)***

"TH has impacted on my job because if the staff tell me that a patient is unwell with some data, it makes my job easier and I can use that information to make a clinical judgement as to what kind of line of treatment is required" ***(RRN2)***

"The good thing is that in the latter part of the study, they were questioning the TH results which they won't have done before TH, this was very good" ***(RRN2)***

"The fear was that you would take responsibility away from the carers. I don't think that we have seen that. The feedback that I have received, is that they have been quite sensible and that they have taken ownership and made sure that the observations have actually been repeated and more accurate" ***(D1)***

Improved HCP relationships were reported by all HCPs working directly with the system. AL HCPs reported feeling more supported and that communication with HCPs external to AL has increased and became of better quality due to availability of data. RRT reported that the increased communication with the same HCPs has supported HCP relationship development between AL and RRT and improved decision making. Increased communication resulted in trust increased between external and internal HCPs.

"Now, we receive a call back. In the past there was no contacting us. We know that someone else is monitoring and supporting us and our residents as a home for health and safety. We do not make decisions alone; our decisions are supported by Rapid Response" ***(AM)***

"The communication has gotten better e.g. when they contact the GP or are on a GP ward round on Tuesdays and Wednesdays, they have the vital signs available" ***(RRN2)***

"The good thing is that you develop a relationship because it was the same people that we were talking to every week" ***(RRM)***

Theme 6: Emotions and Optimism

HCPs expressed positive feelings of optimism and that that TH should be a future priority for care homes. AL management and HCPs reported that TH is important and should be a priority for a care home and that that they would like to continue using TH in AL.

"We feel positive about the system" ***(AC1, AC2, AC3, AC4, AC5, AC6)***

"TH should be a priority for a nursing care home" ***(AC1, AC2, AC3, AC4, AC5, AC6, AC7, AC8, AC9, AC10, AC11 and AC12)***

"I think that the THS is very important for a care home" ***(AC13)***

"I would like to continue to use it at AL" ***(AM)***

However, some HCPs had mixed views and/or felt that TH should not be a priority for care homes but rather residential homes and that they could manage without it. RRT and HCN reported that TH should not continue in care homes in the current format, as

believed it to be of limited value and rather more training is provided on results interpretation.

"The THS is a definite priority for a residential home but for a good nursing home where nurses are monitoring the residents, I am not sure how important it will be" ***(D5)***

"I don't think that TH should be a priority for a nursing care home because we should be trained enough to interpret our own results" ***(RRN1)***

"On one occasion I asked AL about the THS and they told me that they found it cumbersome. There was one resident which is very difficult to control which was suddenly hypoglycaemic. You are not going to prevent that. TH would have not prevented that. I don't want TH; I can manage without TH" ***(D6)***

"I don't think AL should continuing using TH in that form. My personal view is that it has not given any added benefit" ***(HCN)***

Theme 7: Memory and Reinforcement

Despite the barriers faced during implementation of TH at AL, an AL nurse reported that they had adopted the technology as a part of their daily work. Both AL and RRT management and AL HCPs reported that the system was easier to use than expected after a colleague had trained them.

"The THS is a part of us now" ***(AN2)***

"I don't think that AL found it particularly difficult to use the equipment" ***(RRM)***

"At the start it was difficult, now my staff are used to the system and it is easy" ***(AM)***

"When I got to know the system, I realised that it is very easy, I can do the job myself. The first day someone had to teach me how to use it but after that I found it easy" ***(AC7)***

"Initially, I thought that TH will be really difficult but as I used the system, I felt that it was simple" ***(AN1)***

Theme 8: Behavioural Regulation

As reported above (Theme 3), vital signs were previously only taken and recorded monthly before the implementation of TH. The THS ensured that vital sign measurements were taken and recorded at least once a week and highlighted the need to monitor vital signs regularly and promoted contact and professional clinical communication and handover to external HCPs. The change in frequency of vital sign monitoring behaviour and its benefits was noted by all HCPs directly involved in using the THS. The implementation of THS resulted in staff rotating between floors, to maintain nursing care standards, they therefore started seeing the value of using the THS on other floors. The THS allowed the electronic recording of vital signs in the system and therefore improving the clinical documentation.

"Once the THS puts pressure on the staff that the reading must be taken if not daily, at least weekly. If we don't have the THS, the readings will only be taken when needed. When an incident happens, they will start checking the frequency of the readings. If the readings are only taken monthly, this is not acceptable. If we do not use the THS, then we will not have contact with external support services." ***(AM)***

"TH has highlighted the need to monitor vital signs weekly as a routine and the need to act on it." ***(RRN2)***

"If the staff can tell me the results for observations done five days a week and what the normal observations of a resident is because the resident can't talk to you, it would be beneficial to residents." ***(P2)***

"I think that TH is a priority to AL because it ensures regular monitoring of the healthcare of residents and a proper regular record of resident's health status." ***(AN1)***

"We didn't have the vital signs available before. Taking vital signs is part of their routine now but once they have finished the pilot, I am sure that that culture of monitoring vital signs will be there." ***(RRN2)***

Theme 9: Future Intentions

HCPs reported their thoughts and recommendations regarding the future use of TH including suggested disease states, the frequency of monitoring, training, feedback,

awareness and understanding of HCPs, patient and ward types (location), HCP collaboration and how to future support TH implementation.

The HCN, doctors and RRT nurses recommended that TH be used for both residents with dementia and chronically medically unwell residents e.g. COPD and heart failure.

"If we are looking at care homes, the most suited residents for TH will be dementia residents or residents with COPD or heart failure" ***(HCN)***

"I think TH would be of most benefit to residents with mild and severe dementia" ***(D4)***

"I think that TH should be used end of life span, recurrent chest infections, COPD residents and chronically ill people" ***(D5)***

"I would use TH on a different floor. I would like to use it on the ground floor as it is more acute medical residents and would be a better choice" ***(RRN2)***

All HCPs strongly expressed the need for increased frequency of monitoring, training, feedback, awareness and understanding in the future. HCPs requested more training to improve knowledge, awareness and understanding of the purpose of TH and their role so that they can support the implementation of TH. This is not surprising as external HCPs e.g. GPs and RRT were offered no training and thus reported feeling isolated (as above) if they were not directly involved in using the THS whilst RRT although involved in using the system felt confused due to the lack of training. It was also recommended that management take responsibility for ensuring that all new staff receive training. Paramedics, doctors and AL carers recommended that vital sign monitoring be increased to daily instead of weekly to increase clinical value and usability of measurements to support decisions.

"It needs to continue with a purpose and staff need to understand what that purpose is e.g. just doing it two days a week because someone has told them to do that. There needs to be a proper appreciation, understanding and commitment. It needs to be at least five days, that is, every 24 hours" ***(P1)***

"TH success is dependent on the care home. I think that all staff need to be aware of it and to understand how it works and what is the purpose of it and to comply with it and support it and ensure that it is running safely and effectively" ***(D4)***

"I would have like there to be more training next time" ***(D6)***

"I think you need to do it in conjunction with the quality and training of staff. Unless that happens, it would help but not that much" ***(D3)***

"AL management needs to ensure that the new staff are trained on how to use the THS" ***(AC13)***

*"I also think that there needs to be more criteria around it because a weekly blood pressure/heart rate check will not tell you much I would say. I think that if it becomes a pattern that they get done weekly and it will be easy for them to do. I think that untargeted, once a week observation of residents is probably of limited benefit because we call, and they say that everything is fine****" (D1)***

HCPs who are external to AL and support both AL and patients in the community reported that future implementation of TH should be focused on *residential and non-nursing care homes* to yield the maximum benefit from the technology for both HCPs and participants and 'fill the current gap' in community (residential) and non-nursing care environments. Benefits of community implementation included enabling community participants to maintain their independence for longer periods of time through the support of TH.

"We thought that maybe a residential non-nursing care home or a patient in their own home might be better because they don't have the medical support. It is something that we can see the benefit of and the benefit of residents using it in their own homes. I can definitely see a gap there that we should be using it but we are not even thinking about it" ***(RRM)***

"I do not think that TH is appropriate for a nursing care home because they should automatically be monitoring vital signs whereas residential homes will need prompting and support to be beneficial. I think that TH will be more beneficial in a residential home than a nursing home because there are no nurses in a residential home, but you have key workers in a residential who are not medically trained but are trained to monitor vital signs. I think that we have done a study in patient's private home who have no dementia or memory issues that was more productive." ***(RRN2)***

"I have seen the cases for residential homes and that would make more sense to me in that regard particularly in Croydon where we have many residential homes. I do

wonder whether taking the THS out of AL and moving it into a residential non-nursing home would provide more value because that skills set doesn't already exist there. You can train someone to do an automated blood pressure easy and that result gets interpreted elsewhere" ***(D1)***

HCPs reported that *future clinical alignment* of TH is imperative to the successful implementation of TH and would require: a text alert delivery confirmation system to ensure RRT receive alerts, dementia friendly equipment e.g. comfortable barcoded wristbands and non-invasive monitoring equipment e.g. a scanning thermometer and a dementia friendly weighing scale.

"Definitely make sure that we were receiving the information. We need to ensure that all the correct information is being transmitted and that everything is in place and to give us the parameters to begin with" ***(RRN1)***

"We could use wristbands instead which might be less uncomfortable. We can maybe use different temperature probes" ***(HCN)***

"I think the scanning thermometer would have been better for older residents especially with dementia or some sort behaviour problem as a probe thermometer was not accepted" ***(RRN2)***

"We could go forward and start doing things like blood sugar monitoring for our diabetic residents as well. There is lots of areas in which it could open up opportunities" ***(RRN1)***

To improve *future clinical alignment,* the HCN, doctors and RRT also requested remote access to the THS whilst internal HCPs requested more equipment to monitor residents on other floors of AL. The RRT reported that there is a need to establish a seven-day week support team for TH especially on the weekends whilst the HCN reported a need to provide education to AL HCPs that would support both personal and advance care plans for residents. GPs reported that TH needs to be embedded in the future as a supportive part of a personalised care plan including end of life with a wide change culture strategy across all services being implemented to support its adoption.

"I think that TH could be a tool, but I think for a targeted cohort of residents e.g. if I am changing medication, I would want to know what the observations are over the next

week or two and it would be nice to look at them remotely so that I don't have to call anyone" ***(D1)***

"I think that one machine is not enough. We need one machine per a floor" ***(AC3)***

"It's about having system in place so that the patient doesn't fall through the gap. I think it is who monitors that concerns me because although we have staff who work seven days a week, we are very much a reduced service on weekends and that's when our residents and homes get vulnerable because there isn't that back up from GP" ***(RRM)***

"We need to link TH with an understanding of Do Not Attempt Resuscitation and advanced care planning, that is, a whole systems approach but not only based on the THS. I think that if you can make them patient specific, then they will be much more meaningful. With that, we have to have an education programme, advanced care planning for residents, DNARs, clinical scenarios e.g. if this happens, this is what you do and then we have conversation over a tablet in real time" ***(HCN)***

"There needs to be a change in culture as to how we manage these people as well as to providing the personal and medical care plans and support services for which telemedicine can fit into. Providing telemedicine and saying someone else will look at the observations is a particularly useful tool. I think that it needs to be part of a wider transformation piece that includes the home and wider support services. Implementing new services is relatively easy but actually embedding it within the existing services is actually hard. TH when utilised in care homes needs to be accessible by other support services" ***(D1)***

HCPs reported that in the future, multi-disciplinary HCP collaboration is imperative to the successful implementation of TH. RRT suggested that teamwork with other disciplines could result in positive benefits e.g. more accurate parameters set in consultation with GPs and the Geriatrician. RRT and GPs reported that they would like to be more involved in the implementation of TH and that it should be discussed in their forums before implementation so that the logistics of implementation and their roles can be understood. Lastly, the HCN reported that TH needs to facilitate real-time consultations to enable effective decision for making for patients care.

"We can continue to use TH at AL if all parties are willing to adapt and work together especially management and the GPs" ***(RRN2)***

"We never got to see parameters because we never got access to the system. It might have been quite nice if we sat with our Geriatrician to set parameters" ***(RRM)***

"Any new service should be clearly be brought into a forum e.g. a network. We need to explain who is going to do this. Why are we doing it? What are the benefits of doing it? How long are we going to be doing it? How are going to look at the results and who are the users?" ***(D6)***

"I would just do the beginning of TH differently. We have a meeting on a Monday, someone could come in and tell us about it and say we have got residents? Would you like to be involved in choosing the residents? I think give a bit more ownership to staff that are involved. I think going forward, if we were to do it again, people will happy to, but it would be nice to have that little bit more involvement" ***(RRM)***

"They can use the THS as a real time consultation with clinician about a patient that they are concerned about. I want them to tell me to what the blood pressure is and why they are concerned about it. I want the technology to support their clinical decision making and the professional communication" ***(HCN)***

HCPs most importantly reported that *support* is required to ensure the successful implementation of TH. Examples of support included: ensuring HCPs have time allocated to perform TH functions, ensuring that systems support the implementation and maintenance of TH e.g. the GP electronic patient record software supported by EMIS Health[305] (Egton Medical Information Systems supplies electronic patient record systems and software used in primary care, acute care and community pharmacy in the United Kingdom) should allow easy recording of TH interventions and that text alert parameters are regularly maintained, ensuring that there is both externally and internally trained HCPs (champions) to support users and conduct regular training sessions and that management is proactively engaging with research and funding to support the sustainable use of TH.

"Management and the CCG should dedicate time into the GP workload for TH" ***(D5)***

"We recorded a text message or phone call on a spreadsheet, but it was not appropriate to put them onto EMIS. Going forward, if we were going to do a pilot again, or if it was trialled anywhere else, we would have to put those residents in a separate area e.g. long-term conditions or TH area in EMIS. We could learn from that for next time. It's about changing parameters halfway through and who is going to do that, that is, who is the right person to do that?" ***(RRM)***

"Having somebody in their own group telling them the importance of TH would be more successful rather than an external person coming in. Two designated key workers that are in charge during the two days that they are monitoring. Their responsibility is to cascade the reasons to staff as to why we are using TH so that staff have a better understanding of why they are using TH. Some staff will do that and that's why I have key staff in mind that will own this project and result in a better response from the staff" ***(RRN2)***

"There needs to be a dedicated role to have the freedom to implement a THS that meets the needs of Croydon. Whether we are looking at residential or nursing homes, we need money and research underpinning it. We want it to move forward and be evaluated properly under supervision of a dedicated role" ***(HCN)***

"We should have a refresher training day for the staff who missed out. We need to refresh training every three months because of new staff coming in and staff on leave" ***(AC11)***

"Management needs to engage better. Failure to engage is a failure" ***(D6)***

2.5.4. TH impact on AL Culture

Although many pitfalls and barriers were reported with mixed views regarding the benefit and future use of TH, the above themes in both the pre and post interviews suggest that the implementation of the THS resulted in a change in the service offered to patients and organisational working culture at AL. Table 2.19 provides a summary of such changes in practice as deduced from the interviews. The THS increased the monitoring frequency of vital observations of residents and increased the awareness and autonomy of the nurses and carers at AL. The TH text alerts resulted in increased professional responsibility, professional communication, and trust between different healthcare teams. The THS created a proactive approach to responding to the symptoms of residents and changed the role-based care previously offered into person-centred care. HCPs reported feeling more empowered in handling situations that they would have previously accepted blame. The THS seems to have increased the rotation of staff between different floors and the keeping of accurate clinical electronic records of vital observations. These changes were reported by both internal and external HCPs who are responsible for the care of residents of AL.

Table 2. 19: Cultural Changes due to Telehealth

Pre-TH	**Post-TH**	**Theme**
Monthly Monitoring	Frequent Monitoring at least weekly	Goals and Beliefs
Decreased HCP Responsibility	Increased HCP Responsibility	Professional Role and Responsibility
Segmented Healthcare teams	Increased Professional Communication and Teamwork between Healthcare teams	Professional Role and Responsibility
Limited trust between HCPs	Increased trust between HCPs	Professional Role and Responsibility
Role-based Care	Person-centred Care	Barriers to TH Implementation
Reactive Healthcare	Proactive Healthcare	Goals and Beliefs
Blame culture	Empowerment of HCPs	Goals and Beliefs
Staff Allocation confined to one floor	Rotation of staff between different floors	Behavioural Regulation
Poor Documentation	Electronic Real-Time Documentation	Behavioural Regulation

2.6. System Usability Scale (SUS) Results

Table 2.20 shows that the evaluation of the THS using SUS. A system is considered acceptable if the SUS score is above 70 (Appendix 8).[299] Only the HCPs who had access and were directly interacting with the THS [Rapid Response Nurses (SUS=71.3), Albany Carers (SUS=70.4) and Albany Management (SUS=77.5)] ranked the system as acceptable whereas those HCPs [Doctors (SUS=56.3), Paramedics (SUS=57.7) and RRM (SUS=62.5)] who did not directly interact with the THS ranked it as unacceptable.

Table 2. 20: Average SUS Scores per Participant Category

Group	n	Average Score
Doctors	6	56.3
Rapid Response Nurses	2	71.3
Rapid Response Management	1	62.5
Albany Management	1	77.5
Albany Nurses	2	77.5
Paramedics	2	57.5
Albany Carers	14	70.4

2.7. Discussion

The increasing prevalence of dementia within a resourced challenged social care system has been highlighted as a goal of the NHS Long Term plan to improve care to patients with dementia whether they are in a hospital or a home.[7,155] The WSD[30,31 27,28] has proven that TH can lower the frequency of hospital admissions, duration of hospital stays and mortality rates. Patients with dementia are nearly three times more likely to die during an admission for an acute medical condition compared to those without dementia.[248] Therefore, an assessment of a TH solution for residents in care homes by measuring patients' response frequency to GPV, AP, ED and IP admissions and HCPs' pre and post TH experiences and their perceptions of the TH implementation was conducted.

The participant selection resulted in a median age (86.0 years) similar to the national reported average of 85 years old for residents living in care homes[306] and the participants' incidence (23.7%) of moderate severity of dementia was lower to the previous reported by Dementia UK (32.1%).[201] However, only 14 of the 27 residents were able to complete the AMTAP phase of the study highlighting the importance of the role of the PI to consult with key stakeholders e.g. the nurses of the residents at AL to aid in selecting suitable participants to ensure the acceptability of the intervention by residents in terms of the expected discomfort and distress and the impact of this on participants non-compliance. Poor resident selection was also reported under this theme due to behavioural issues e.g. residents moving their hands during blood pressure vital observations resulting in unnecessary text alerts. Although participants met the eligibility criteria on enrolment, participants inability to complete the study due to clinical progression is indicative of the variable rate of deterioration in participants and the nature of the disease itself. This suggests an underestimation of disease deterioration at recruitment. We also need to consider that participants were unable to complete the study due to poor acceptability of the THS peripherals e.g. perceived to be invasive and/or poor applicability of the THS to a nursing home with residents with dementia. The former potentially suggest the lack of comprehension of what the study involved by residents, as consent was based on verbal explanation of the study rather than actually showing each participant what each measurement will entail. Lastly, carers whilst having received training on how to take observations with the THS peripherals, may not have received training on how to communicate with residents with dementia

effectively to support participant adherence whilst taking observations. This may have also impacted on the ability of participants to complete the study measurements.

Poor study implementation resulted in several missed opportunities for TH to have an even greater benefit to patients. Site selection can affect outcomes. The lack of person-centered approach to care e.g. doing observations at different times of the day when residents were less likely to become agitated may have resulted in more successful adoption of the THS. Also, setting personalised parameters during CP resulted in the generation of unnecessary red text alerts that resulted in RRT only responding to 31% of the red text alerts. These barriers were enhanced by delayed text alerts due to the TH tablet not being docked properly. Consulting the advice of the Consultant Geriatrician in the RRT and the residents GPs before the implementation of TH would have been beneficial as they are familiar with the specialist therapy area and residents' personal parameters. This approach would have resulted more beneficial outcomes for both patients and the HCPs.[90] A poor strategic fit in study protocol implementation e.g. suboptimal timing of vital sign recordings acquisition, unnecessary text alerts, equipment failure, inability of equipment to take multiple readings simultaneously and lack of extra staff on TH monitoring days may have compromised the potential benefit of the THS. Other examples of poor implementation included: poor alignment with the current care pathway and lack of advance care plans, lack of Electronic Management Information System (EMIS) preparation, poor system integrity e.g. not ensuring text messages are received, poor human resource allocation, and a 'TH Care Gap' that existed after normal working hours. The design of the WHELD study[232] protocol has considered the participants and implementation environment and similar consideration should have been afforded to this study design as the 10am-2pm is the busiest time for staff and residents involvement in other activities e.g. bathing or lunch and thus the timing was unsuitable for observations to be recorded.

Regardless, the THS (Table 2.6) seemed to have developed an increased HCP awareness of the health status of residents with a statistically significant increase in GPV (n=7, f=59, p=0.009) and AP (n=12, f=44, p<0.001) from CP to AMP. The increase in GPV and AP resulted in a decrease in hospital ED (n=2, f=28, p=0.454), IP (n=2, f=25, p=0.607) and mean IP days (6 days) during AMP as residents were being more closely monitored and treated in AL rather than hospital. The introduction of the text alerts and RRT support during AMTAP (Table 2.7) seems to have had an even greater

effect on increasing GPV (n=4, f=11, p=0.09) and AP (n=6, f=17, p=0.031). Nearly half, 47.7% of the GPV (n=31/65) and 90% of the AP (n=18/20) were due to text alerts. During AMTAP, there was a decrease of 11 admissions for both ED and IP (p=1) and the mean IP duration decreased by 30 days when compared to CP. These results show that TH has the potential to raise HCP awareness resulting in earlier treatment of disease, prevention of hospital admissions and reduced length of hospital stays and achieves the goal of the Five Year Forward vanguard to reduce avoidable hospital admissions by ensuring that care home residents get their health needs regularly assessed and met.[2]

Studies have reported that residents with dementia have a higher risk of avoidable unplanned emergency hospital admissions and poorer outcomes due to co-morbidities, medical history, and disease associated delirium.[175,176] Preventable infections have been reported as the main driver of both hypoactive (more ill on admission and have had longer durations of hospital admission) and hyperactive delirium (most likely to fall whilst in hospital).[250,251] In addition, falls, urine and chest infection are three of the most common causes of admissions in dementia patients.[248] The THS (Table 2.8) has successfully reduced hospital admissions for three preventable reasons of admissions [falls(16→1), urinary(7→5) and respiratory tract infections(3→2)] during AMP (n=27) potentially preventing delirium, long hospital stays and falls in hospitals. Despite the THS reducing hospital admissions, there was a missed opportunity as the THS did not have a peripheral to monitor blood glucose levels as recommended by a systematic review and meta-analysis[50] and thus the THS had no impact on diabetes resulting in the strongest correlation ($\tau b = 0.693$, $p<0.001$) between having type 2 diabetes and being admitted for hypoglycaemia during AMP (Table 2.9). The reduction in hospital visits is an important outcome as it meets the goals of the GSFCH and the NHS Long Term Plan to reduce hospital mortality and ensures that residents with dementia receive improved end of life care and can die with dignity in the location of their choice.[7,266–268]

The text alerts during AMTAP (Table 2.10) moved the clinical decision autonomy from AL (local) to RRT (remote) as it required the Albany nurses to report to the RRNs resulting in a conflict of roles. This may have resulted in an increase in hospital admissions for two preventable conditions during AMTAP [falls (5→6), pneumonia(0→1)]. The text messaging to RRT may have disempowered the AL HCPs

of their professional role and responsibility by changing the direction of command to the RRT. The direction of change, role of emotions and political behaviour of management can influence the acceptance of a system and the initial enthusiasm during AMP may have been dampened during AMTAP.[307]

The increased awareness of HCPs due to the implementation of the THS and medicines optimisation as discussed below may have driven the reduction observed in hospital admissions for falls from CP to AMP [(n=2, f=5) to (n=1, f=1), (n=14)) and from ((n=3, f=16, to (n=1, f=1), (n=27)], especially in those residents that had a history of falls (Table 2.11). as there was only a strong positive statistically significant correlation ($\tau b = 0.68$, $p=0.012$) between having arthritis/osteoarthritis and being admitted for a fall during CP and not AMP or AMTAP indicating that the THS can prevent hospital admissions for falls despite having a previous medical history of falls. Smart wearable body sensors could have been connected to the THS to trigger a text alert and this could increase the HCP response time.[84]

The THS (Table 2.12) has increased HCPs' awareness of residents' potentially inappropriate medication (PIM) resulting in the statistical significant ($p<0.001$) increase in the addition of medication from CP (m=16) to AMP (m=54) as the most prevalent STOPP-START intervention.[253,255] The largest amount of medication was optimised (add medication) during AMTAP with an increase of medication added from 10 in CP to 37 in AMTAP, thus 3.7 medication per resident compared to 5.3 (Table 2.13), as RRT promoted the prescribing of medication as a risk avoidance clinical decision. Most interestingly, the THS significantly moved the location of the medication optimisation from hospital to AL during AMP ($p<0.001$) and AMTAP ($p=0.016$).

A previous study identified that medication reviews in residential care homes can reduce the risk of inappropriate prescribing.[254] The results identified a shift in prescribing from high risk medication to lower risk medication. There was also an increase, as outlined above, in antibiotic prescribing to decreasing the rates of avoidable emergency admissions such as those caused by infections, a marker used by policy makers for improved health outcomes considering the financial constraints in the NHS.[308] The large decrease in admissions due to falls during AMP, resulted in RRR of falls during AMP of [(n=27, 93.8%), (n=14, RRR=80%)] and an OR of falls during AMP of [(n=27,

OR=0.0625, 95% confidence interval 0.0077 to 0.5051, p=0.0093), (n=14, OR=1.2, 95% confidence interval 0.2962 to 4.8617, p=0.7984)]. This could have been due to lower risk medication and those of lower risk of inducing falls being prescribed during AMP, highlighting the need for pharmacists to regularly review care home medications.[261]

In fact, HCPs identified that the THS improved both work efficiency and clinical effectiveness. The improved clinical effectiveness was achieved by improved changed response to the healthcare needs of the residents. The full clinical benefit of the system was compromised by poor recruitment, non-inclusive approach to all HCPs, lack of training and resources. This resulted in missed opportunities for optimisation. Pre-implementation, HCPs were concerned about losing face to face contact with patients and professional skill however, post implementation HCPs reported that they had increased their professional skills and professional communication.[69]

Cork[309] and Deegan et al.[310] have reported on the importance of leading and managing change to achieve successful outcomes. The lack of management support was consistently highlighted through the study. A doctor best explained: *"Management needs to engage better. Failure to engage is a failure"* ***(D6).*** The report by the CQC during their annual inspection of AL highlighted the lack of management support.[311] The lack of management support manifested multiple reported barriers to technology adoption e.g., shortage of staff and delays in equipment repair. Managers need to have contingency plans in place to overcome potential chasms[100] of capacity and context e.g., critical management incidents included the removal of the Nursing Manager post at AL during the AMP (September 2016) and the retiring of the study's PI at the end of the AMP (14th February 2017) resulting in a management transition gap until the Cluster Matron took over. Critical incidents occurred during the study that affected the environment and resources available. This resulted in the RRT not knowing that the AMTAP had started and thus they did not know that text alerts were not being delivered due to a system error. Once the Cluster Matron was notified of this, this error was quickly resolved highlighting and supporting the need for a TH Operational Manager role. The operational manager would have helped to clearly define HCP roles, give HCPs feedback, increase supportive resources, set personalised parameters for residents, identify system failures and address issues immediately, remove residents that have passed on and work with GPs to update and sustain the THS.

Management chasms also include the contextual environment and the perceived usefulness of the THS in a care home with clinical nurses available, which was questioned by HCPs before and after implementation. Non-nursing environments e.g., private community homes and non-nursing residential homes would most benefit from TH as a supportive system by alerting clinical support when needed.

Perceived ease of use and perceived usefulness affects HCPs' attitudes, beliefs, perceptions and intentions of the THS and ultimately their adoption of the system.[133] The HCPs at AL were concerned about the ease of use of the THS as they had not worked with a THS previously. Lack of training was highlighted by all respondents during this study as a major failing despite being well documented previously as a barrier to successful TH implementation.[69,70] The lack of training left those untrained feeling isolated. This represents a missed opportunity of multidisciplinary collaborative working: *"It became an AL project rather than a GP-AL project"* ***(D6).*** However, the RRNs acted as facilitators after the initial training pre-implementation to teach the nurses at AL how to use the THS. HCPs who received training and used the system rated the system as acceptable (SUS≥70) unlike the ones that didn't. Management needed to increase awareness and understanding of TH by training, more hierarchical feedback so that line managers can support HCPs and having internal TH champions to promote and support behavioural change. The latter are considered important facilitators of innovation adoption.[287] The lack of adequate training offered was a common issue in AL. The CQC report highlighted that management had not ensured that staff had completed mandatory training and thus were at risk of not having up to date knowledge and skills to undertake their duties and provide residents with appropriate support.[311] The lack of training culture was regarded as imperative due to the high staff turnover and a lack of advanced care planning for residents.

Another previously reported barrier[69] to technology adoption[133] was the suitability of the THS to the environment e.g. the blood pressure cuff and thermometer were not suitable for use with dementia residents as it increased their BPSD[201–205] symptoms of agitation. Ironically, the goal of the THS was to reduce the carer burden[63] and the unsuitable

peripherals resulted in increasing their burden thus furthering their misconceptions on the effectiveness of the THS. HCPs reported that both hardware and software system support needs to be increased going forward as vendors of both the hardware and software had not provided adequate service levels during the study. This would involve regular equipment maintenance and calibration, software access and training and text alert delivery confirmation systems. Immediate recommendations of the current system included: barcoded wristbands for residents, dementia friendly weighing scales, blood glucose and a scanning thermometer. Delivery of text alerts need to be verified to ensure action from HCPs. An important learning was the need to improve the strategic alignment and implementation of TH within the current care pathway by improving General Practitioner support, personalised parameter settings and advanced care plans and online real-time consultations with general practitioners and this was asked in the interviews *"Are we going to link TH with the clinical management plan or a patient specific protocol?"* ***(HCN)***.

There was an incident of a TH alert being generated just before a doctor ward round that resulted in the doctor caring for the patient at a faster rate and this was recorded in the CQC inspection report.[311] Fortin et al.[288] and Patterson et al.[290] have highlighted the importance of successful telehealth experiences as above in order to encourage adoption. Albany nurses reported that they only recorded vital observations monthly before the THS was implemented. The THS encouraged the recording of vital sign once a week. This practice was unfortunately not frequent enough to directly prevent admissions but did improve the nursing frequency of vital sign recording adding to the successful experience of using telehealth for the nurses. Whilst, increasing monitoring frequency from weekly to daily would provide a greater awareness and understanding of TH, the impact on residents with dementia would not make implementation feasible. THS can be used to identify resident's vital observations trends and support detailed handovers e.g. to paramedics especially in residents with dementia who cannot communicate a change in health status. Hospital admission occurred on days that TH was not used. If it was used daily, then there was potential to identify a change in health status and treat locally earlier and prevent an admission.

Despite the above-mentioned barriers to adoption and HCPs being unaware of the impact of the THS on GPV, AP, ED, IP and duration of hospital admissions, HCPs reported that they would like to continue to use TH. This was similarly reported by Odeh et al.[70] who evaluated the feasibility of using a remote monitoring telehealth system in homes of patients with LTCs. However, HCPs did indicate that the THS could be more beneficial in a different environment e.g., a non-nursing home, different therapy area e.g. COPD or CVD.

2.7.1. Future development of the system

Despite the lack of success in terms of persistence in using the THS, this study provided many lessons to be learnt for future adoption of technology. This study would have benefited from a pre-implementation feasibility study to achieve study objectives. A feasibility study would have also highlighted and refined the inclusion criteria, the frequency of monitoring and the study duration. The THS can be used to record clinical scenarios that can be used as an educational tool for staff. Staff need to be trained on the early recognition and treatment of infection. Furthermore, clinical knowledge of the staff needed to be evaluated at baseline and training offered accordingly. Whilst the THS is effective at increasing awareness, observation skills and clinical intuition must be developed as we cannot solely rely on a system to make clinical decisions thus more resources need to be allocated to training. A root cause analysis of each admission can be used as a learning tool to prevent future admissions. HCPs must be adequately trained to use equipment and associate readings taken with observations of the patient e.g. if the SpO_2 reading is equal to 66% (Normal > 92%), it is highly unlikely for a patient who has a healthy pallor and the reading should be retaken for verification. GPs need to request blood results to identify clinical changes more timeously. Medication reviews need to be conducted regularly to enhance patients' safety and reduce avoidable admissions e.g. falls. The rapid deterioration of health status of elderly residents with dementia requires more frequent medication reviews to optimise drug utilisation. GPs need to review residents regularly as the system cannot be solely relied on to identify changes in health status of residents. GPs who regularly review residents who are not well increase the chances of preventing an admission. TH may not prevent an admission directly but could create an awareness and highlight the need for closer healthcare monitoring by HCPs. Nurses need to be more assertive and request GPs to review

residents more regularly. Nurses need more autonomy to action the required care for their residents. An earlier review by HCPs can triage residents who are unwell to more cost-effective treatment options e.g. using an Acute Care of the Elderly (ACE) clinic instead of an unplanned emergency hospital admission. The THS should have the ability to allow HCPs who are taking measurements to view previous recordings of same measurements that is historic trends at the time of taking a reading. This will empower the HCP to determine the necessary action required immediately after taking the reading. The current model will not achieve the intended goals due to the lack of education, communication, and staff utilisation of equipment. Therefore, future recommendations of the system:

- Video consultation feature of the system needs to be implemented. This will allow GPs and RRT to view the patient during remote consultations and enhance the communication between HCPs.
- Intensive teaching within the care homes that allow them to evaluate residents holistically, that is, consolidate the reading results with their observations and have the conversation with the GP about any extra care that is needed.
- TH cannot be implemented in isolation. It needs a robust HCP support structure to ensure its success.
- Question trees need to be evaluated and enhanced.
- Assessments need to be taken daily.
- Robust end of life planning is essential to the successful implementation of TH.
- TH might be more beneficial in a residential home as compared to a nursing care home. A model should be developed using the learnings from this study to develop an improved model for residential homes.
- The THS results should be used to reverse engineer the training needs of HCPs. Continuous learning will develop the system intelligence and enhance the value contribution of the system to the residents.

The RPS[261] has made the following recommendations that are relevant to this study:

- Pharmacists should have overall responsibility for medicines and their use in care homes.

- One pharmacist and one general practitioner should be responsible for medicines in each care home ensuring co-ordinated and consistently high standards of care.
- Where a care home specialises e.g. in dementia care, the pharmacist should ensure they are competent to support the relevant clinical speciality.
- Local commissioners (such as Clinical Commissioning Groups or NHS England) should commission pharmacists to provide medicine reviews within care homes.
- Pharmacists should lead a programme of regular medicine reviews and staff training, working in an integrated team with other healthcare practitioners ensuring medicines safety.

2.7.2. Limitations and Conclusion

The THS used in a care home with residents having dementia yielded the following limitations resulting in inaccurate results:

- The residents are all very elderly people who would have naturally declined in time. So, would this have happened anyway?
- Some residents viewed the system as invasive, the stress experienced changed their results and generate results that are not a true reflection of a patient's current health status.
- The acceptability of the THS to participants with dementia needs to be evaluated e.g. some of the participants did not feel comfortable using the blood pressure cuff.

The inevitable decline in dementia over time and the co-morbidities and BPSD associated with it may have resulted in increased resistance to using the peripherals of THS and increasing the mortality of residents. Therefore, decreasing the sample size for evaluation which was already limited. Other limitations included the following:

- Parameters were not customised during the study and thus readings can also be affected by co-morbid conditions e.g. cardiac failure and/or atrial fibrillation.

- Residents with dementia may not always be able to supply a urine sample for analysis which limited the answering to one of the health questions.
- It can be difficult to identify and prevent a fall and an admission using the current system as fall sensors were not used.
- AL does not use a computer system to keep records. Missing documentation of events could have resulted in missing data. All clinical events were verified at two sources at minimum to enhance validity and reliability of data.
- The busy nature of the environment did not allow for smaller focus group session with carers so not all carers may have expressed their opinions during the larger focus group session.

Overall, the main limitation of the study was the small sample size for the quantitative evaluation of the THS. So, although the analysis was conducted, it needs to be treated in caution and further analysis completed to confirm the impact of a THS in care homes. Nevertheless, the value observed through the increased medication changes to lower risk ones, increase in GP visits, reduction in duration of admission, and increase in antibiotic prescribing, are encouraging and indicate preliminary evidence of such a solution in care homes, to enhance clinical and professional effectiveness and efficiency which were also echoed in the interviews.

2.8. Author Contributions

Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND	✓
Drafting the work or revising it critically for important intellectual content; AND	✓
Final approval of the version to be published; AND	In progress
Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.	✓

Chapter 3: Preventing Early Hospital Re-Admission using a digital predictive algorithm system (OPTIMAL)

3.1. Background

The scarcity of healthcare resources is a common challenge of all countries and is often faced in an environment of increasing demand.[312] The challenging goal of increasing the quality of healthcare without increasing the cost, can only be achieved through creating efficiencies within healthcare systems. One of the challenges faced in healthcare systems is that patients discharged from hospital are extremely physiologically and psychological vulnerable and can end up being readmitted due to lack of post-discharge care.[313] Prevention of early (<30 days) hospital readmissions is a priority of all countries including the UK that has benefits for both patients and providers.[314] UK hospitals have been financially penalised for patient readmissions that occurs within 30 days of discharge since 2011 to prevent early discharge of patients.[315] Whist denying of payment for emergency readmissions has been reported as having the potential to improve quality of care by improving data systems and reducing error, new systems of denial of payment could be dangerous if they invoke perverse incentives.[316]

A study has reported that 15% of over 65-year-olds in England are readmitted within 28 days.[317] A retrospective analysis of 83 million routinely-collected national hospital episode statistics (HES) records covering NHS hospitals in England for a 6-year period (2004–2010) categorised causes of emergency 30-day readmissions into: potentially preventable (probable or possible suboptimal care during index admission, n=1,988,967 ,27.8%), approach to care (anticipated but unpredictable hospital care, n=1,503,282, 21.0%), due to preference of patients or staff in admission or discharge timing (n=56,514, 0.8%), artefact in data collection (n=139,508, 2%), accident or coincidence (n=1,473,583, 20.6%) and no obvious cause (n=2,107,339, 29.4%) totalling n=7,166,304 (8.7%) emergency 30-day readmissions of all hospital discharges.[316] This analysis concluded that the highest category of reasons for readmissions was preventable and there was scope for reduction of preventable readmissions in the NHS.[316]

The last reported cost of readmissions in the UK to the NHS was £2.4 billion in 2012-2013.[318] Healthwatch England reported that from 2012 to 2017, there was a 22.8% (372,805 to 457,880) increase in emergency readmissions, with the number of emergency readmissions within 24 and 48 hours of discharge increasing by 29.2% (49,529 to 63,964) and 27% (77,927 to 98,955) respectively with readmissions within

48 hours accounting for 21.61% of the total readmissions.[319] The report concluded that the increasing prevalence of readmissions especially within 48 hours is of concern and requires further investigation.[319] In 2019, The King's Fund reported the cost of an ambulance trip as £252, emergency department visit as ranging from £45-400 and one GP visit as costing £37.40.[308]

On the 21st March 2019, NHS Digital has reported new experimental statistics that show emergency readmissions for hospitals in England between 2013/14 and 2017/18.[320] The report outlined that there has been an increase in both the percentage and number of patients that have had emergency readmissions within 30 days from discharge: 01/04/2013 to 31/03/2014 (n=756,024, 12.5%), 01/04/2014 to 31/03/2015 (n=789,594, 12.8%), 01/04/2016 to 31/03/2017 (n=812,056, 13.2%), 01/04/2017 to 31/03/2018 (n=826,157, 13.3%) and 01/04/2017 to 31/03/2018 (n=865,629 , 13.8%).[320] A similar trend is seen at CUH: 01/04/2013 to 31/03/2014 (n=5,258, 13.9%), 01/04/2014 to 31/03/2015 (n=5,253,14.6%), 01/04/2015 to 31/03/2016 (n=5,406,13.9%), 01/04/2016 to 31/03/2017 (n=5,397,14.5%) and 01/04/2017 to 31/03/2018 (n=5,494, 14.1%).[320]

Guidance from the National Institute of Healthcare and Excellence (NICE)[321] on the transition between inpatient hospital settings and community or care home settings for adults with social care needs highlights the importance of the pre and post discharge care and good communication between healthcare professionals. In fact, numerous studies have highlighted the importance of correct discharge and follow up and adherence to medication and lifestyle guidance to prevent or reduce the risks of early readmissions of patients.[322–324] NICE also recommends that all patients/carers are provided with a medication list and a care plan (discharge letter) with a single healthcare professional being responsible for co-ordinating the discharge for both social and medical needs.[321]

In 2003, the WHO reported that 30% to 50% of medicines prescribed for long term conditions are not taken as intended.[325] In 2012, the DH reported that 15 million people in England have long-term conditions (LTCs) and LTCs increase with age, that is, 14% of people aged under 40 years and 58% of people aged 60 years and over report having at least one LTC.[4] In 2012, the Royal Pharmaceutical Society (RPS) reported that 60% of patients have three or more changes made to their medicines during a hospital stay and that only 10% of older patients will be discharged on the same medication that they

were admitted to hospital on.[326] In 2015, the NICE guideline: "*Medicines optimisation: the safe and effective use of medicines to enable the best possible outcomes*" on medication optimisation reported that when patients move from one care setting to another e.g. at the time of hospital admission or discharge, 30% to 70% of patients have an error or unintentional change to their medicines and that has a significant impact to patients and is a considerable burden on the NHS.[327] A study has reported that 20% of patients have been reported to experience adverse events within three weeks of discharge, 60% of which could have been managed or avoided.[328]

In April 2005, the first Community Pharmacy Contractual Framework (CPCF) was launched, and services were initiated within to meet the growing population that are living with LTCs.[329] One level of service introduced within the contract, were advanced services which included medication use reviews (MURs), where a pharmacist will systematically undertake a review with a patient that is taking medication for LTCs. The New Medicine Service (NMS) was a later addition to the advanced services as it was introduced in 2011 to support people with LTCs newly prescribed a medicine to improve medication adherence.

In 2018, Kayyali et al.[330] (n=357) reported that 70% of patients had changes made to their medications during a hospital admission, yet only 40% were consulted about them and two-thirds (62.2%) of patients wanted to be involved in shared decision making (SDM). The study outlined that nearly two fifths of patients thought that medication counselling before discharge could be improved and that most patients were interested in receiving the MUR service after discharge however most of them were not aware of it. In 2019, NHS Digital reported that the median length of stay following an emergency admission to hospital at a national (1 day) and local (3 days).[331] A 2020 UK survey study (n=347) of patients discharge experience from hospital reported that nearly half (n=146/374, 42.1%) were not informed of the discharge decision 24 hours in advance, including 43.4% (n=43/99) of those who lived alone and about a quarter (21.3%,n=74/374) were discharged between 18:00 and 06:00 with 17.6% (n=13/74) of them living alone with an average age of 71.2 years.[152] This study reported that only two-thirds (67.4% n=234/347) of patients agreed that the decisions regarding the discharge procedure were clearly explained however, only a third of patients (34.3%, n=119/347) were provided with information to enable them to detect signs of deteriorating health.[152] Unfortunately, only a third of patients (33.4%, n=116/347) were

provided with contacts for out-of-hours support.[152] Less than a third (27.4%, n=95/347) of patients were referred to a post-discharge service and less than half (48.4%, n=46/347) of respondents reported joining this service.[152] A sample of patients (20.8%, n=72/347) reported the following concerns: lack of communication between hospital staff and the patients/patients' families (48.6%, n=35/72, including two elderly patients discharged without informing their families), long waiting times (36.1%, n=26/72) and 42.3% (n=11/26) of the waiting times involving a delay in receiving medications.[152] It was therefore not surprising that one patient stated: *"More co- ordination is needed between the pharmacy and wards"*.[152] In the above study, three-quarters of patients (75.2%, n=176/234) reported that their medication was changed whilst in hospital but over a quarter of these patients (28.4%, n=50/176) were not counselled and 34.6% (n=81/234) would have liked more information regarding their medications.[152] Post discharge, patients 70.3% (n=244/347) who received medication counselling in hospital were significantly (p=0.013) more confident in managing their own healthcare issues but less confident in manging their social care issues (34.3%, n=119/347).[152] More than half (54.5%, n=189/347) of patients did not receive any healthcare support from a hospital, general practitioner (GP), pharmacy or other post-discharge services within 30 days from hospital discharge.[152] Whilst only 4.0% (n=17/347) of patients were referred for MUR at their local pharmacy, 50.4% (n=175/347) of patients were interested in an MUR. Likewise, 78.9% (n=274/347) of patients were not referred for NMS but 51.6% (n=179/347) reported being interested.

In 2018, a systematic review and metanalysis of 47 randomized trials reported that the relative risk (RR) of readmission within 30 days was 0.82 (95% CI, $p < .001$) and that interventions with many components (p= 0.001), involving more individuals in care delivery (p= 0.05), and supporting patient capacity for self-care (p= 0.04) were 1.4, 1.3, and 1.3 times more effective than other interventions, respectively.[332] Thus, complex interventions that support self-care are mutually beneficial to both providers and patients to prevent early hospital readmissions.[327] A 2019 UK study (n=756) showed that when patients aged over 65 years are contacted (n=288) within 48 hours of discharge by a nurse to discuss post discharge care issues and offered a home visit by a general practitioner referral (n=202), and medications advice, there was a significant decrease in the readmission rate, that is, 9.24% compared to 15.67% where no attempt to contact them was made (p=0.011).[333]

In 2021, the Discharge Medicines Service (DMS) became a new essential service within the CPCF.[334] The DMS consists of three phases: Stage 1 (A discharge referral is received by the pharmacy), Stage 2 (The first prescription is received by the pharmacy following discharge which may not be a repeat prescription) and Stage 3 (Check of the patient's understanding of their medicines regimen).[334] PharmOutcomes® is a web-based system that allows hospitals and GPs to refer patients for a DMS post hospital discharge.[335]

3.1.1. Predictive Modelling of Readmissions

A systematic review in 2011 (7843 citations, 30 studies) of risk reduction models for hospital readmission identified 26 readmission risk prediction models including the Probability of Repeat Admission (PRA) and Electronic Readmission Model.[323] This systematic review reported that from the 26 models identified: fourteen models relied on retrospective administrative data that potentially could be used to reduce readmission rates of which nine had poor discriminative ability, seven were suitable for high risk patients and five could be used at hospital discharge.[323] This systematic review also reported that functional (e.g. co-morbidities, medical history, illness severity) and social (e.g. marital status, education) variables can improve a model's discrimination and that only one model (Switzerland)[336] specifically addressed preventable admissions.[323]

In 2012, Billings et al.[337] developed an algorithm (PARR-30) to identify inpatients at high risk of re-admission to a NHS hospital in England within 30 days of discharge by performing multivariate and logistic regression statistical analysis of routinely collected hospital data between April 2008 and March 2009 (10% sample of all admissions, n=576 868). The algorithm consisted of 20 bands and calculated a ''risk score' ranging (0–1) for each admitted patient. For example, at a risk score threshold of 0.5, the positive predictive value (percentage of inpatients identified as high risk who were subsequently re-admitted within 30 days) was 59.2% (95% CI 58.0% to 60.5%).[337] This algorithm predicted 5.4% (95%, CI 5.2% to 5.6%) of all inpatients who would be re-admitted within 30 days (sensitivity).[337] In 2018, a Scottish study (n=55,975) of ICU survivors performed a multivariable logistic regression analysis reported a 24.1% (CI: 23.7% to 24.4%) 90 day readmission rate and that pre-existing factors e.g. previous admissions in last 12 months and co-morbidities (c-index=0.63) were better predictors of readmission than acute illness factors (c-index=0.60) or demographics (c-index=0.54).[338] The results of this study is interesting as similar results have been identified in COVID-19 risk of death or hospitalisation prediction models e.g. QCovid® risk calculator.[339] In 2020, a UK hospital study (14,878 men and 17,392 women, mean age 64.0 years) analysed retrospectively collected data of alive-discharge episodes between 1st April 2017 and 31st March 2019.[340] The LACE index (higher index = poorer health, Scale=0-4, 5-9, ≥10) was used to predict 30-day readmission in patients on medicine and surgery wards. The proportion of patients readmitted at 28 days (0-4=0.1%,5-9=1.3% and ≥10=9.2%)

and at 2 years (0-4=1.7%,5-9=4.8% and ≥10=19.1%) concluding that the LACE index predicts short-and long-term readmissions.[340]

3.1.2. OPTIMAL

EXUS is an enterprise software company that uses mature and new technologies to manage healthcare research activities.[341] They formed a consortium with Kingston University and Croydon University Hospital in a collaboration aiming to optimise the hospital discharge mechanism to prevent unnecessary readmissions using the OPTIMAL system.[341] OPTIMAL was an Innovate UK funded project that was deployed at CUH in 2017 to optimise the hospital discharge mechanism in order to prevent unnecessary readmissions.[341] The project was designed to estimate the probability of a patient hospital readmission (OPTIMAL risk ratio) using an algorithm that was developed through analysing previous patient admissions to reveal the patterns in the hospital admission of patients and the most common factors leading to readmission for similar patient profiles.[341] OPTIMAL aimed to optimise hospital patients' follow up processes, especially during the first month after discharge, with a clear goal to reduce readmissions by 5% within the first year of its installation at CUH.[341]

CUH is in London largest borough in South East London. CUH has 670 beds, eight operating theatres, a day surgery suite with three theatres, two obstetric theatres and recovery room with a discharge rate of over 10,000 patients per year and a reported readmission rate of 14% in 2015 which was close to the readmission rates reported by NHS Digital (12.8%) for the same year.[342] CUH has the following wards with active admissions and discharges: Purley 1, Queens 2, Heathfield 2, Purley 2, Queens 1, AMU, Heathfield 1, Purley 3, Queens 3. Discharge Advocates (DAs), as a post discharge intervention implemented as part of OPTIMAL, were allocated to support participant patients to ensure that they have received their discharge letters and that post-discharge care is co-ordinated for both their social and medical needs. The intervention aimed to demonstrate a reduction in readmission rate within the first month of discharge by 5% in the period from 5th June 2017 to 30th July 2018. To study the effect of the intervention, a randomised controlled trial design was used.

A total of 1700 patients were required to achieve a 95% confidence limit for a 5% reduction in readmissions. As part of this randomised controlled trial, patients who consented to take part in the trial were allocated into one of two groups: control and

intervention with 850 patients in each group (Figure 3.1). Patients were excluded from the study if the patient: declined consent, lacked capacity for consent, was under 18 years old, was in the Maternity Ward, had a childbearing medical condition, had a life expectancy of less than 3 months had been re-admitted within the last 30 days since discharge and/or had been admitted electively (not through A and E).

The first group of patients received the intervention and is referred to in this chapter as the intervention group. The intervention is a system supported phone call from the DA post discharge to ensure that the patient received the required post discharge care. The DA used the OPTIMAL system as part of the intervention to monitor and track post discharge care of patients. The OPTIMAL system directed the DA to ask the patient 13 questions: *How do you feel? (1 very poorly, 5 excellent)*, *Do you have easy access to food?*, *Do you have easy access to toilet facilities?*, *Do you have access to heating and lighting?*, *Do you have all your medication?*, *Do you know how and how often you need to take them?*, *Do you know of any changes to your prescription?*, *Has the district nurse visited you at home?*, *Do you have a carer and are they helping you take your medication?*, *Do you know what you need to be doing next (GP Appointments, Outpatients etc)?*, *Do you know what to do if your situation gets worse?*, *Do you have a blister pack? Do you need one?* and *Do you feel that you will need to come back to the hospital?* The DA was also directed by OPTIMAL to recommend but not limited to 15 actions to support patients as necessary post discharge. These actions included possibly arranging: a GP appointment, a review in COPD Hot Clinic[343] (Respiratory Consultant led Clinic that accepts urgent community referrals of patients with an acute respiratory problems and aims to treat patients in the community and prevent hospital admissions) in 2 - 3 days, a review in Rapid Assessment Medical Unit (RAMU) clinic in 2 - 3 days, a review at local pharmacy for medicine management advice, care of the elderly to visit, physiotherapist to visit, occupational health to visit, a review in Surgical Hot Clinic in 2 - 3 days, an early Outpatient Department (OPD) review by clinical discharge team, hospital avoidance team to visit in 1 - 2 day, the continence service to visit, other social service to visit and add details to contact notes, a patient to be informed on elective appointment, Age Concern to follow up and/or Red Cross to follow up with patients who received the intervention. The DA uses the OPTIMAL system when contacting patients to track and record patient responses to questions and recommendations. Intervention patients could receive one or more phone calls post

discharge. The second group of patients (control group) did not receive the intervention. Control patients received the normal discharge standard of care and did not receive any telephone calls or input from the DA.

Although OPTIMAL was initially built for CUH, the project was expanded to Sherwood Forest Trust (SFT). Patients (n=353) admitted to SFH were recruited by 16 DAs during the period 14th March 2018 to 28th June 2018 and randomised to the Intervention arm (n=169) and the control arm (n=184). However, SFT did not allow any patient identifiable data to be imported from their hospital system to the OPTIMAL system and this made linking of data from the SFT hospital system to the OPTIMAL system data challenging. Extraction of data reports from the OPTIMAL system revealed that patient responses to the DA questions and actions taken by DAs were not recorded on the system. Therefore, this chapter focuses on the evaluation of the experience of CUH patients about the new discharge care pathway proposed by OPTIMAL due to the limitation of data sharing and poor OPTIMAL system implementation at SFT.

3.2. Aim and Objectives

The aim of this study was to evaluate the intervention implemented as part of OPTIMAL in terms of patient satisfaction and readmission rate.

The aim was achieved via the following objectives:

- To evaluate patients' satisfaction with the OPTIMAL discharge intervention and its effect on their discharge experience.
- To evaluate the rate of readmission with and without the intervention

3.3. Methods

3.3.1 Study design and sample

This study is an evaluation of the original OPTIMAL RCT which was ethically approved by the NHS Integrated Research Application System (IRAS, IRAS ID: 223682). Random sampling techniques were used by the DAs to allocate subjects into the intervention and control arms of the study. The researcher then further randomised subjects into phone evaluation and computer evaluation arms for both the DA's intervention and control arms. Using an online Raosoft® sample size calculator[344], it was determined that for 850 patients per a group, a sample size of 265 patients evaluations per a group (total 530) would be needed to determine patient satisfaction levels at 95% confidence interval.[344]

To seek feedback of patients, post discharge, a cross-sectional study design took place. Questionnaires were developed for the intervention and control groups. The control group questions contained a subset of questions from the intervention questionnaire. The questionnaire for the intervention group contained 49 questions in three sections (Appendix 18). The first part required the recording of patient's demographic and CUH admission data from Cerner (the electronic patient records and medical hospital notes system) e.g. ward, gender, ethnicity, age, admission and discharge date. The intervention group questionnaire required the recording of the DA call resolution date and outcomes from Optimal. The next section used multiple option answer questions to ask patients: who provided them information related to the discharge, if there was any medication removed, changed or added before discharge, who counselled them if there were any changes to their medication before discharge and if they had received a care plan before leaving the hospital. The next section used a 5-Likert Scale (Not confident at all, Not confident, Neither, Confident and Completely Confident) question format to ask patients how confident they were about their medication, social care issues e.g. cooking/mobility and health changes (in case of deterioration) immediately after leaving hospital and whether they were expecting any follow up appointments. The intervention questionnaire of this section used multiple option answer questions to evaluate the call patients received from the DA in term of the purpose of the call, timing of the call post discharge, acceptability of the duration of the call and confirming that the DA checked that the patient received their follow up appointment dates, follow up on any outstanding appointments/referrals or made any additional appointments/referrals for the patient and

asked the patient to share the types of upcoming additional appointments/referrals. The last section asked patients on the usefulness of the call from the DA using a 5-Point Likert Scale by enquiring if patients felt that the DA understood (1=Didn't Understand to 5=Fully Understood) their health problems, did they find the call helpful (1=Unhelpful to 5=Very Helpful), what was most helpful and if there was anything else, they would have liked to have discussed with the DA. Using multiple option answer questions the next question in this section asked patients if they had made any additional appointments/referrals themselves and asked the patient to share the types of self-booked upcoming additional appointments/referrals. Lastly, the last two multiple option answer questions asked the patient if they were waiting to hear about any other appointments and asked the patient to share the types of additional appointments/referrals.

Pilot testing of questionnaires was undertaken in June 2017 on 31 patients and resulted in numerous changes to the initial questionnaire design including seven additional questions: Was this time convenient?, Were you expecting an follow up appointments?, Would you mind telling me what they were?, Did the nurse make any additional appointments for you?, Did you attend these appointments or are you still waiting to hear from them?, Have you attended any of these appointments or are you still waiting to hear from them? and two questions removed: Do you feel you need more information or support at the moment?, How did your support during this discharge compare to your last discharge?. The redesigned questionnaire was re-evaluated in August 2017 on 8 patients resulting in no further changes required. As some patients were not contactable for evaluation, as also experienced in the pilot testing phase, a secondary evaluation form was developed that allowed patients to be evaluated using only the secondary data from Cerner and Optimal system, so using computed data only.

Thus, there were 4 different evaluation questionnaire forms using the nomenclature of the method of evaluation and the group (See Appendices 19-22):

1. Intervention patients who were spoken to (49 questions) = Phone Intervention

2. Intervention patients who were not spoken to (21 questions) = Computer Intervention

3. Control patients who were spoken to (30 questions) = Phone Control

4. Control patients who were not spoken to (14 questions) = Computer Control

Using the questionnaire, an evaluation call was then conducted after the DA intervention was resolved or within 10 days after the discharge of patients from the control group, to assess the success of the intervention from the patient perspective as well as any impact on patient satisfaction with their discharge. Patients were initially telephoned on a landline by the researcher at least twice and if no contact was made, they were contacted using mobile technology. If there was no response to a mobile call, voicemail and text messaging features of mobile technology were used to leave a message for patients to contact the researcher. If not return call was received from patients, the patient was assigned to the shorter 'not spoken to' evaluation. Most patients were contacted for the evaluation within the following timescales: 2 to 10 days since discharge for control patients and within 2 to 10 days of the last call from the DA for the evaluation patients. After 30 days from the end of the discharge, the patients who had been evaluated were verified for readmission using Cerner. If a patient had been readmitted within 30 days extra data was recorded for the patient: Date of readmission, reason for readmission, number of days since discharge and a flag indicating whether the readmission was for the same reason as the primary admission (Figure 3.1: Patient Study Journey). This chapter provides an analysis of the patients who were discharged during the period from September 2017 to June 2018.

3.2.2. Ethics consideration and consent

The OPTIMAL RCT was ethically approved by the NHS Integrated Research Application System (IRAS) (IRAS ID: 223682), Croydon University Research and Ethics Committee. This evaluation was covered within the approval of the trial. Patients' consent was acquired upon their recruitment on the trial by the two DAs employed a part of the project. The DAs were supported by ward nursing staff and clinical teams in CUH to identify those patients due to be discharged within the next 72 hours. DAs approached patients identified to discuss the study and gave them the study Patient Information Sheet (Appendix 16) and Consent form (Appendix 17) and answered any questions as needed. Formal consent was taken face to face, after the patient has had time to read the Patient Information Sheet (24 hours). The consent form had 3 sections: Section 1 is consenting to take part in the study, Section 2 is consent to a telephone interview after

30 days following discharge (as an evaluation of the intervention- the main objective of this study) and Section 3 is consent for data to be used for validation of risk of re-admission. Only patients who have given informed consent were included in the study. Patients who consented to the study were included on the recruitment log. The recruitment log held the patients name, surname, age, ward, date of consent and randomisation.

The data captured during this study was held in an electronic format within the OPTIMAL system. The OPTIMAL system is located within the Trust server and has links to the electronic patient records and medical hospital notes system (CERNER). Any paper documents were held in a local site file, kept in the Research and Development office and behind locked doors. Copies were scanned for filing within the patient records. If at any time the patient felt they no longer wish to take part in the study, the patient was withdrawn, and their data was deleted.

3.2.3. Data Analysis

Data extracted from the questionnaires, the OPTIMAL and CERNER (CUH hospital) systems was anonymised and transferred to SPSS v.26 for analysis. Two data sets were created in SPSS for the larger original sample (n=1475) and the evaluated smaller sample (n=530). Data was classified as nominal e.g. gender or age, ordinal e.g. responses to Likert scale questions or data formulated in groups (age groups) or scale variables e.g. OPTIMAL risk score or previous admission in last 12 months. The classification of data into categorical (e.g. gender) or continuous (e.g. age) determined the statistical test used to compare the means [T-Test, ANOVA (greater than 2 categories), Fischer's Test (if 20% of cells have expected frequencies < 5)], association or correlation [(Chi-squared test to test the association between two categorical variables) and Pearson Correlation (if correlating two continuous variables)] between variables. The critical level of significance for statistical testing was set at 0.05 (5%) for all tests.

In addition to the inferential analysis to identify statistically significant difference between means of the intervention and control arms and correlation and association between variables, data was analysed descriptively. The frequency of events was calculated e.g. the frequency of ward admission, discharge information received from different HCPs,

changes of medication at discharge and medication counselling at discharge per each study arm. These were expressed as numbers and percentages and are reported in tables with negative frequencies having a minus sign in front of the number. The frequencies of patients' responses to survey questions were also calculated as numbers and percentages and provided as tables and bar charts as appropriate. The total and mean hospital stay was also calculated. To report the causes of admission, the original hospital admission codes (n=229) were grouped into 57 simplified codes for ease of reporting without losing the essence of the coding. The mean Likert scale was calculated to compare the experience of those readmitted with 30 days to those not readmitted within 30 days.

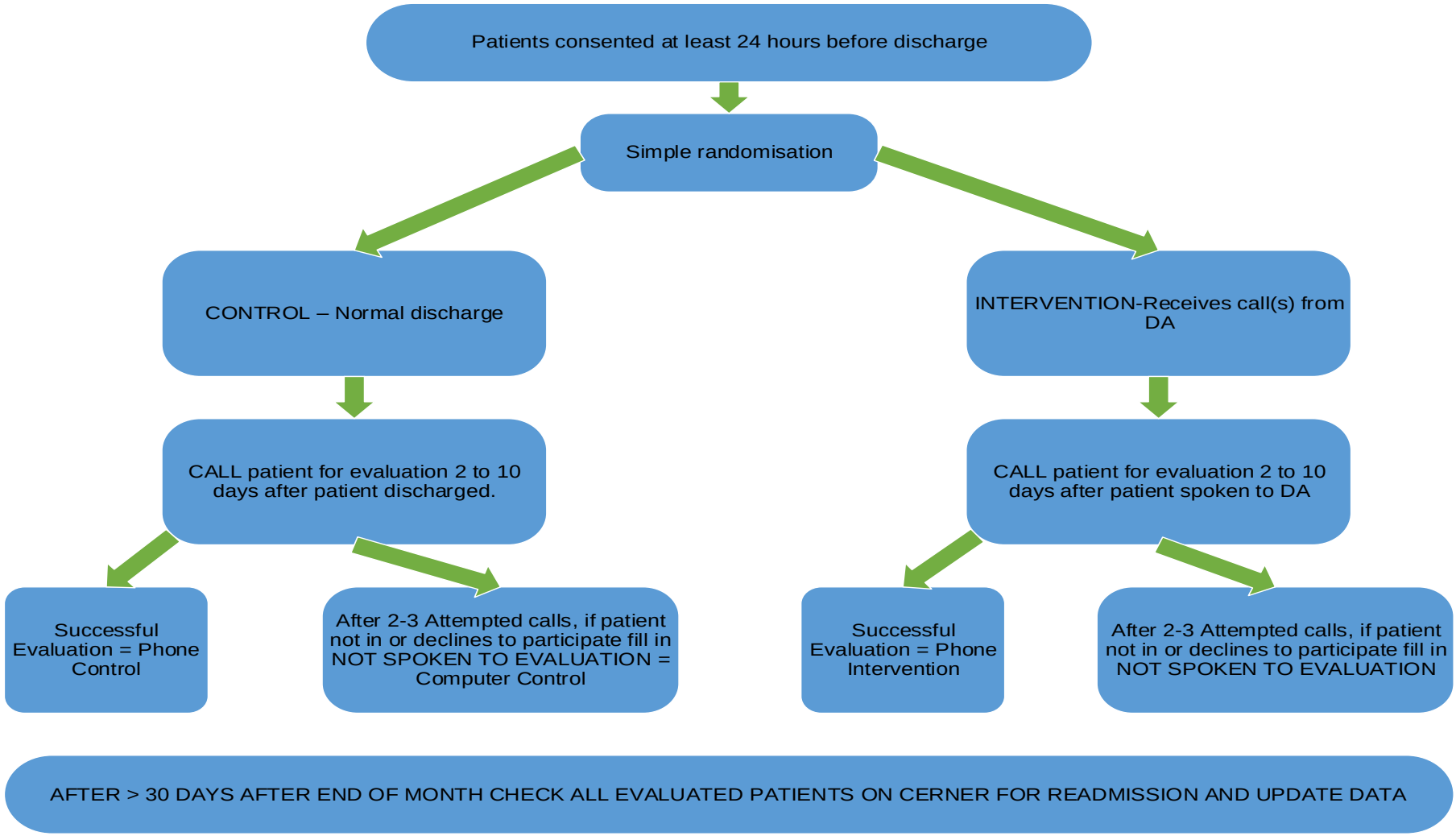

Figure 3. 1: Patient Study Journey

3.3. Results:

3.3.1. Sample size and Demographic data

During the study period, 814 patients were recruited into the intervention group and 798 patients were recruited into the control group. Patients were excluded based on the exclusion criteria as described in section 3.1.2 e.g. one patient was below 18 years old in the intervention group and therefore could not legally consent. System errors occurred due to human error in data capture and inadequate system data. After excluding patients that were recruited on more than one occasion into the study, 745 intervention group patients and 730 control group patients were eligible for evaluation (Table 3.1).

Table 3. 1: Patient recruitment, exclusions and eligibility

	Intervention	**Control**
Total Recruited (5/6/17 to 30/6/18) n	814	798
System Errors n (%)	55 (6.8)	56 (7.0)
Duplicate Recruitment n (%)	13 (1.6)	12 (1.5)
Underage n (%)	1 (0.1)	0 (0)
Exclusion Total n (%)	69 (8.5)	68 (8.5)
Eligible Patients n (%)	745 (91.5)	730 (91.5)

To evaluate patient satisfaction, we aimed to evaluate 530 intervention and control patients via a phone call. Telephonic contact was successful with 180 patients who received the intervention (67.9%) and 177 control patients (66.8%). However, for patients who could not be contacted telephonically, computer evaluations were completed (intervention: n=85, 32.1%) and (control: n=88, 16.6%). Table 3.2 shows the distribution of the four different types of evaluations.

Table 3. 2: Evaluation types

	Intervention Computer	**Intervention Phone call**	**Control Phone call**	**Control Computer**	**Total**
Total n (%)	85 (32.1)	180 (67.9)	177 (66.8)	88 (33.2)	530

Table 3.3 shows that there are no major differences in the age and gender of patients recruited into the intervention (n=745) and control groups (n=730) in the trial when compared to the patients evaluated from the intervention (n=265) and control (n=265) group. It must be noted though that the mean age was slightly higher in both the

evaluated arms compared to the whole population. The Chi-Squared (χ^2=1.118, p=0.290) test result showed a non-significant difference in gender between the intervention (n=745) and control (n=730) groups. The T-Test (t=0.394, p=0.354) result showed a non-significant difference in age between the intervention (n=745) and control groups (n=730). Similarly, the Chi-Squared test result (χ^2=0.272, p=0.602) showed a non-significant difference in gender between the evaluated intervention (n=265) and control (n=265) groups. The T-Test result (t=0.568, p=0.199) showed a non-significant difference in age between the evaluated intervention (n=265) and control groups (n=265). In addition, the Chi-Squared test result (χ^2=0.598, p=0.439) showed a non-significant difference in gender between the evaluated eligible (n=745+730=1475) and evaluated (n=530) groups. When comparing the larger sample to the evaluated sample, the T-test for age (t=-2.29, p=0.022) was statistically significantly different.

Table 3. 3: Patient demographics: age and gender

	Intervention n=745	**Control n=730**	**Evaluated Intervention n=265**	**Evaluated Control n=265**
Age Mean	55.9	56.82	57.51	59.52
Range	18-95	18-96	19-95	20-93
18-39 n, (%)	170 (22.8)	166 (22.7)	49 (18.5)	53 (20)
40-59 n, (%)	225 (30.2)	209 (28.6)	78 (29.4)	65 (24.5)
60-79 n, (%)	273 (36.6)	271 (37.1)	115 (43.4)	115 (43.4)
80-100 n, (%)	77 (10.3)	84 (11.5)	23 (8.7)	23 (8.7)
Female	393 (52.8)	365 (50)	137 (51.7)	131 (49.4)
Male	352 (47.3)	365 (50)	128 (48.3)	134 (50.6)

Table 3.4 shows that there are no considerable differences between the ethnicity distribution of patients for both the intervention (n=745) and the control study groups (n=730) for the study and the intervention (n=265) and control (n=265) evaluation groups. It is perhaps worth noting that over 50% of the patients were classified as White British. When comparing the larger sample to the evaluated sample using ANOVA, there

was no statistically significant difference in ethnicity between the two groups (F=1.102, p=0.351).

Table 3. 4: Ethnicity distribution

	Intervention n=745	**Control n=730**	**Evaluated Intervention n=265**	**Evaluated Control n=265**
Total: Ethnicity	745	730	265	265
Other - Not Stated n (%)	72 (9.7)	66 (9.0)	27 (10.2)	24 (9.1)
Other - Any Other Ethnic Group n (%)	23 (3.1)	33 (4.5)	4 (1.5)	8 (3.0)
White - British n (%)	387 (52.0)	374 (51.2)	136 (51.3)	148 (55.9)
Mixed - White and Black African n (%)	3 (0.4)	0	1 (0.4)	0
Asian or Asian British - Indian n (%)	31 (4.2)	28 (3.8)	9 (3.4)	11 (4.2)
Black or Black British - African n (%)	33 (4.4)	26 (3.6)	13 (4.9)	8 (3.0)
Black or Black British - Caribbean n (%)	45 (6.0)	34 (4.7)	15 (5.7)	11 (4.2)
Black - Any Other Black Background n (%)	29 (3.9)	44 (6.0)	12 (4.5)	11 (4.2)
White - Any Other White Background n (%)	36 (4.8)	48 (6.6)	15 (5.7)	18 (6.8)
White - Irish n (%)	13 (1.7)	16 (2.2)	6 (2.3)	3 (1.1)
Not known n (%)	12 (1.6)	7 (1.0)	3 (1.1)	3 (1.1)
Mixed - Any Other Mixed Background n (%)	8 (1.1)	6 (0.8)	2 (0.8)	3 (1.1)
Mixed - White and Black Caribbean n (%)	7 (0.9)	7 (1.0)	2 (0.8)	2(0.8)
Asian - Any Other Asian Background n (%)	26 (3.5)	27 (3.7)	12 (4.5)	7 (2.6)
Mixed - White and Asian	1 (0.1)	2 (0.3)	0 (0)	2 (0.8)
Asian or Asian British - Pakistani n (%)	15 (2.0)	9 (1.2)	6 (2.3)	6 (2.3)
Asian or Asian British - Bangladeshi n (%)	3 (0.4)	1 (0.1)	1 (0.4)	0 (0)
Other – Chinese n (%)	1 (0.1)	2 (0.3)	1 (0.4)	0 (0)

3.3.2. Admission Risk, Duration and Causes

Table 3. 5 below shows that there were no major differences in the ward admissions for the intervention and control patient groups included in the study and the evaluated intervention and control patient. The wards with the most activity was Ambulatory Medical Unit (AMU), Queens 2 and Queens 1, Purley 2 respectively for the intervention and control patient groups from the study. For the evaluated intervention and control groups, patients were mostly from AMU, Queens 2 followed by Heathfield 2 and Queens 1. The wards with the least activity were Heathfield 1, Queens 3 and Purley 3 respectively for the intervention and control patient groups from the study and the intervention and control patient from the evaluation groups. It is worth noting that most recruited patients from AMU. An ANOVA analysis resulted in a statistically non-significant mean difference in wards when comparing the eligible (n=1475) to evaluated (n=530) arms (F=1.476, p=0.163), the eligible intervention (n=745) to the evaluated intervention (n=265) (F=2.076, p=0.056) arms and the eligible control (n=730) to evaluated control (n=265) (F=0.666, p=0.677) arms. An ANOVA analysis resulted in a statistically significant difference in means when comparing the eligible control (n=730) to the eligible intervention (n=745) (F=2.952, p=0.003) arms and evaluated intervention (n=265) to evaluated control (n=265) (F=3.053, p=0.007).

Table 3. 5: Ward Admissions

Ward	Intervention n=745	Control n=730	Evaluated Intervention n=265	Evaluated Control n=265
Purley 1 n (%)	69 (9.3)	72 (9.9)	18 (6.8)	12 (4.5)
Queens 2 n (%)	141 (18.9)	142 (19.5)	37 (14.0)	40 (15.1)
Heathfield 2 n (%)	64 (8.6)	59 (8.1)	34 (12.8)	24 (9.1)
Purley 2 n (%)	79 (10.6)	70 (9.6)	20 (7.6)	16 (6.0)
Queens 1 n (%)	114 (15.3)	107 (14.7)	24 (9.1)	32 (12.1)
AMU n (%)	252 (33.8)	252 (34.5)	119 (44.9)	127 (47.9)
Heathfield 1 n (%)	3 (0.40)	0 (0)	2 (0.75)	0 (0)
Purley 3 n (%)	19 (2.6)	23 (3.2)	9 (3.4)	14 (5.3)
Queens 3 n (%)	4 (0.5)	5 (0.7)	2 (0.8)	0 (0)

Table 3.6 shows that there were no major differences in the speciality distribution of admissions in the intervention and control patient groups in the trial and the evaluated intervention and control groups. General Medicine, General Surgery and Respiratory

Medicine had the highest frequency of admission specialities for the intervention and control patient groups from the study and the intervention and control patient from the evaluation groups.

Table 3. 6: Speciality Distribution

Speciality	**Intervention n=745**	**Control n=730**	**Evaluated Intervention n=265**	**Evaluated Control n=265**
Diabetic Medicine n (%)	34 (4.6)	28 (3.8)	18 (6.8)	11 (4.2)
Gastroenterology n (%)	54 (7.3)	54 (7.4)	20 (7.6)	18 (6.8)
Accident and Emergency n (%)	23 (3.1)	12 (1.6)	5 (2.0)	7 (2.6)
General Medicine n (%)	264 (35.4)	264 (36.2)	114 (43.0)	103 (38.8)
Endocrinology n (%)	21 (2.8)	20 (2.7)	11 (4.2)	12 (4.5)
Respiratory Medicine n (%)	94 (12.6)	87 (11.9)	34 (12.8)	32 (12.1)
Geriatric Medicine n (%)	43 (5.8)	52 (7.1)	12 (4.5)	23 (8.7)
General Surgery n (%)	128 (17.2)	120 (16.4)	33 (12.4)	34 (12.8)
Gynaecology n (%)	30 (4.0)	30 (4.1)	4 (1.5)	5 (2.0)
Trauma and Orthopaedics n (%)	32 (4.3)	38 (5.2)	11 (4.2)	13 (4.9)
Gynaecological Oncology n (%)	1 (0.1)	5 (0.7)	1 (0.4)	1 (0.4)

Colorectal Surgery n (%)	3 (0.4)	5 (0.7)	0 (0)	1 (0.4)
Obstetrics n (%)	1 (0.1)	3 (0.1)	0 (0)	2 (0.8)
Urology n (%)	11 (1.5)	9 (1.2)	1 (0.4)	3 (1.1)
Nephrology n (%)	3 (0.4)	0 (0)	1 (0.4)	0 (0)
Stroke Medicine n (%)	1 (0.1)	0 (0)	0 (0)	0 (0)
Breast Surgery n (%)	1 (0.1)	0 (0)	0 (0)	0 (0)
Diabetic Education Service n (%)	1 (0.1)	0 (0)	0 (0)	0 (0)
Cardiology n (%)	0 (0)	2 (0.3)	0 (0)	0 (0)
Maxillofacial Surgery n (%)	0 (0)	1 (0.1)	0 (0)	0 (0)

Table 3.7 below describes the length of stay of patients in the intervention and control groups within the trial and the evaluated intervention and control groups. The mean length of stay for the intervention (5.35 days) and control (5.53 days) groups for the study was higher than the mean length of stay for the intervention (4.80 days) and control (5.14 days) groups for the evaluation. A T-Test resulted in non-significant means difference in duration of stay when comparing total eligible (n=1475) versus total evaluated (n=530) (t=1.908, p-value=0.057), eligible intervention (n=745) versus eligible control (n=730) (t=-0.48, p=0.631), and evaluated intervention (n=265) versus evaluated control (n=265) (t=-0.696, p=0.487). It must be noted that the Pearson correlation result showed a small positive significant correlation between age and duration of stay in the intervention group (n=745) (r=0.224, p<0.001), similarly between age and duration of stay in the control group (n=730) (r=0.175, p<0.001). This significant correlation was

maintained in the evaluated intervention arm (n=265) (r=0.139, p=0.024), however this correlation was not significant in the evaluated control group (n=265) (r=0.36, p=0.560).

Table 3. 7: Duration of Patient Stay

	Intervention n=745	**Control n=730**	**Evaluated Intervention n=265**	**Evaluated Control n=265**
Total Patient Days	3985	4036	1271	1361
Mean Length of Stay (Days)	5.35	5.53	4.80	5.14
Length of Stay	**Number of patients**	**Number of patients**	**Number of patients**	**Number of patients**
1 to 2 days n (%)	304 (40.8)	307 (42.1)	113 (42.6)	106 (40.0)
3 to 5 days n (%)	214 (28.7)	199 (27.3)	78 (29.4)	80 (30.2)
6 to 10 days n (%)	131 (17.6)	127 (17.4)	46 (17.4)	48 (18.1)
11 and more days n (%)	96 (12.9)	97 (13.3)	28 (10.6)	31 (11.7)

Table 3.8 below shows that there were no major differences in the frequency of patient admissions to CUH for 12 months prior to the study and during the study for the intervention and control groups and the intervention and control groups for the evaluation. Interestingly, majority of recruited and evaluated patients had no admission in the last 12 months before the study and only had one admission during the study. The Pearson correlation (R=0.804, p<0.001) result showed a significant correlation between previous admission in last 12 months before study and admissions during the study for the whole eligible sample (n=745+730=1475) and this was true for the evaluated sample (n=530) (R=0.847, p<0.001). A T-Test resulted in significant mean difference in previous admission over last 12 months when comparing total eligible (n=1475) versus total evaluated (n=530) (t=2.041, p-value=0.042) but a non-significant difference in means when comparing eligible intervention (n=745) to eligible control (n=730) (t=1.494, p=0.136) and evaluated intervention (n=265) versus evaluated control (n=265) (t=0.824, p=0.410).

Table 3. 8: Admission frequency of patients before and during study

	Intervention n=745	**Control n=730**	**Evaluated Intervention n=265**	**Evaluated Control n=265**
Previous admission in last 12 months before study n (%)	305 (40.9)	303 (41.5)	93 (35.1)	101 (38.1)
No admissions in last 12 months before study n (%)	440 (59.1)	427 (58.5)	172 (64.9)	164 (61.9)
One admission during study n (%)	372 (49.9)	353 (48.4)	146 (55.1)	138 (52.1)
Two admissions during study n (%)	146 (19.6)	184 (25.2)	52 (19.6)	64 (24.2)
Three to Five admissions during study n (%)	168 (22.6)	147 (20.1)	51 (19.3)	50 (18.9)
Six or more admissions during study n (%)	59 (7.9)	46 (6.3)	16 (6.0)	13 (4.9)

During the study (Table 3.9), the most common reason for admissions in the control group were cardiac disease (n=22, 8.3%), pneumonia (n=18, 6.8%), gastric inflammation (n=16, 6.0%), lower respiratory tract infections (n=15, 5.7%), renal insufficiency (n=14, 5.3%) and urinary tract infections (n=13,4.9%). In the intervention group, the most common reason for admissions were cardiac disease (n=26, 9.8%), pneumonia (n=21, 7.9%), lower respiratory tract infection (n=18, 6.8%), sepsis (n=14, 5.3%), blood disorder (n=15, 5.7%) and asthma (n=14, 5.3%).

Table 3. 9: Reason for Admissions

Admission Diagnosis	Control (n=256)		Intervention (n=256)		Total
	n	%	n	%	
Abscess	2	0.8%	1	0.4%	3
Alcoholic Inflammation	1	0.4%	5	1.9%	6
Allergies	2	0.8%	1	0.4%	3
Angina	4	1.5%	9	3.4%	13
Appendicitis	8	3.0%	2	0.8%	10
Arthritis	1	0.4%	0	0.0%	1
Asthma	11	4.2%	14	5.3%	25
Blood Disorder	7	2.6%	15	5.7%	22
Cardiac Disease	22	8.3%	26	9.8%	48
Constipation	2	0.8%	1	0.4%	3
Cough	2	0.8%	0	0.0%	2
Diabetes	8	3.0%	5	1.9%	13
Dizziness	8	3.0%	9	3.4%	17
Electrolyte Imbalance	4	1.5%	3	1.1%	7
Embolism	0	0.0%	1	0.4%	1
Endocrine	1	0.4%	0	0.0%	1
Eye Disorder	1	0.4%	0	0.0%	1
Falls	2	0.8%	0	0.0%	2
Fluid Retention	2	0.8%	3	1.1%	5
Fractures	8	3.0%	9	3.4%	17
Gastric Inflammation	16	6.0%	13	4.9%	29
Gout	1	0.4%	2	0.8%	3
Gynaecological	6	2.3%	5	1.9%	11
Hernia	1	0.4%	2	0.8%	3
Hypertension	5	1.9%	1	0.4%	6
Hypotension	0	0.0%	1	0.4%	1
Inflammation	0	0.0%	2	0.8%	2
Injury	10	3.8%	10	3.8%	20
Liver Inflammation	4	1.5%	4	1.5%	8
Lower Respiratory Tract Infection	15	5.7%	18	6.8%	33
Malaria	1	0.4%	1	0.4%	2
Measles	0	0.0%	1	0.4%	1

Mental Disorder	3	1.1%	3	1.1%	6
Migraines	2	0.8%	1	0.4%	3
Multiple Sclerosis	2	0.8%	0	0.0%	2
Neoplasm	2	0.8%	5	1.9%	7
Pain	14	5.3%	10	3.8%	24
Pancreatitis	3	1.1%	1	0.4%	4
Pneumonia	18	6.8%	21	7.9%	39
Poisoning	5	1.9%	4	1.5%	9
Prostate Inflammation	1	0.4%	0	0.0%	1
Renal Insufficiency	14	5.3%	6	2.3%	20
Respiratory Failure	2	0.8%	3	1.1%	5
Seizures	1	0.4%	8	3.0%	9
Sepsis	9	3.4%	14	5.3%	23
Sinusitis	0	0.0%	2	0.8%	2
Skin Infection	9	3.4%	7	2.6%	16
Suspected Cerebrovascular Accident	1	0.4%	2	0.8%	3
Tonsillitis	1	0.4%	1	0.4%	2
Unknown	0	0.0%	1	0.4%	1
Upper Respiratory Tract Infection	4	1.5%	2	0.8%	6
Urinary Tract Infection	13	4.9%	6	2.3%	19
Vascular Complication	1	0.4%	1	0.4%	2
Viral Infection	5	1.9%	3	1.1%	8
	265		265		530

Table 3.10 shows that there was no major difference in the frequency of patients' OPTIMAL calculated percentage readmission risk within 30 days. Majority of patients had a percentage risk of readmission of 1-10% followed by >10 – 20%. However, the risk of readmission was balanced between the control and intervention groups but the evaluated groups had patients with a higher mean percentage risk of readmission (Table 3.11). The Chi-Squared (χ^2=207.209, p<0.001) test result (Table 3.12) showed a significant association between increasing age in the whole eligible sample and

OPTIMAL readmission risk. This test was used due to a SPSS system limitation to calculate the Pearson Correlation in the larger sample (n=1475). The Pearson correlation result (R=0.132, p=0.002) showed a significant correlation between patient age and OPTIMAL readmission risk scores for the evaluated sample (n=530). A T-Test result showed a significant mean difference in OPTIMAL re-admission risk scores when comparing total eligible (n=1475) versus total evaluated (n=530) (t=-3.255, p-value=0.001) as the evaluated arm had a higher admission risk than the whole sample. A non-significant difference in means was calculated when comparing eligible intervention (n=745) to eligible control (n=730) (t=-1.022, p=0.307), and evaluated intervention (n=265) versus evaluated control (n=265) (t=0.620, p=0.536).

Table 3. 10: OPTIMAL readmission risk percentage score

Readmission risk percentage	Intervention n=745	Control n=730	Evaluated Intervention n=265	Evaluated Control n=265
< 1% n (%)	15 (2.01)	16 (2.2)	4 (1.5)	2 (0.8)
1 to 10% n (%)	307 (41.2)	294 (40.3)	87 (32.8)	91 (34.3)
10.01 to 20% n (%)	252 (33.8)	235 (32.2)	77 (29.1)	83 (32.3)
20.01 to 30% n (%)	78(10.5)	81 (11.1)	43 (16.2)	30 (11.3)
30.01 to 65% n (%)	84 (11.3)	91 (12.5)	47 (17.7)	47 (17.7)
65.01% and greater n (%)	9 (1.2)	13 (1.8)	7 (2.6)	12 (4.5)

Table 3. 11: Mean percentage OPTIMAL readmission score

	Intervention n=745	Control n=730	Evaluated Intervention n=265	Evaluated Control n=265
Mean readmission percentage risk	15.95	16.66	20.27	20.91

Table 3. 12: Age Groups versus Optimal Risk Groups

	18-39 years	40-59 years	60-79 years	≥80 years
0 to 10%	238	211	146	37
10.01 to 20%	49	127	241	70
20.01 to 30%	25	34	78	22
30.01 to 65%	21	53	71	30
≥65.01%	3	9	8	2

Table 3.13 illustrates that there was 1.2% readmission reduction between the intervention and control arm. However, there was a 4.15% reduction in the readmission rate in the evaluated intervention arm compared to control. This could be due to the increased OPTIMAL predicted readmission risk in the evaluated arm. A T-Test resulted in significant mean difference in actual readmission rate when comparing total eligible (n=1475) versus total evaluated (n=530) (t=2.682, p-value=0.008) with the evaluated arm having a lower rate of readmission. A T-test calculation showed a significance difference in readmission rates between the evaluated intervention (n=265) and the evaluated control (n=265) (t=-9.393, p<0.001) and a non-significant difference in means when comparing eligible intervention (n=745) to eligible control (n=730) (t=-8.09, p=0.419).

Table 3. 13: Actual readmission rate

	Intervention n=745(%)	**Control n=730 (%)**	**Evaluated Intervention n=265 (%)**	**Evaluated Control n=265 (%)**
Number readmitted within 30 days n (%)	117 (15.7)	106 (14.5)	25 (9.4)	36 (13.5)

Table 3.14 shows the main reason of readmission within 30 days of discharge, was cardiac disease (n=10, 3.8%) and gastric inflammation (n=10, 3.8%). There were more early readmissions within 30 days from discharge in the hospital from the control (n=36, 59%) than the intervention group (n=25, 41%). Table 3.15 shows a cross tabulation of original admission reason versus reason for re-admission within 30 days from discharge. Out of 61 readmissions in both the evaluated arms, 15 (25%) were readmissions for the same reason as the original admission. The mean OPTIMAL readmission risk percentage score for patients admitted for the same reason was 22.77% in the intervention group and 23.74% in the control group. Gastric inflammation (n=3, 4.9%), cardiac disease (n=2, 3.3%), electrolyte imbalance (n=2,3.3%) and sepsis (n=2,3.3%) were the most common reasons for early readmission for the same reason within 30 days.

Table 3. 14: Causes of readmission within 30 days of discharge

	Randomisation		Total
Re-admission Diagnosis	**Control (n)**	**Intervention (n)**	
Angina	1	0	1
Asthma	0	1	1
Blood Disorder	0	1	1
Cardiac Disease	6	4	10
Diabetes	0	1	1
Dizziness	0	1	1
Electrolyte Imbalance	2	2	4
Fluid Retention	1	0	1
Gastric Inflammation	6	4	10
Hypertension	1	0	1
Infection	1	0	1
Injury	1	1	2
Liver Inflammation	3	1	4
Lower Respiratory Tract Infection	1	0	1
Multiple Sclerosis	0	1	1
Neoplasm	2	0	2
Pain	1	2	3
Respiratory Failure	1	0	1
Seizures	0	2	2
Sepsis	2	1	3
Unknown	1	1	2
Upper Respiratory Tract Infection	1	1	2
Urinary Tract Infection	5	1	6
Total	**36**	**25**	**61**

Table 3. 15: Readmission versus Original Admission

		Admission Diagnosis																												
		Alcoholic Inflammation	Angina	Appendicitis	Asthma	Blood Disorder	Cardiac Disease	Constipation	Dizziness	Electrolyte Imbalance	Falls	Fluid Retention	Gastric Inflammation	Gout	Inflammation	Injury	Liver Inflammation	Lower Respiratory Tract Infection	Multiple Sclerosis	Pain	Pancreatitis	Pneumonia	Renal Insufficiency	Respiratory Failure	Seizures	Sepsis	Skin Infection	Suspected Cerebrovascular Accident	Urinary Tract Infection
Re-admission Diagnosis	Angina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Asthma	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blood Disorder	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Cardiac Disease	0	0	1	0	0	2	0	0	0	1	0	1	0	0	1	1	0	0	1	0	2	0	0	0	0	0	0	0
	Diabetes	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dizziness	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Electrolyte Imbalance	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	Fluid Retention	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gastric Inflammation	0	0	0	1	2	0	0	0	0	0	0	3	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1
	Hypertension	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Infection	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Injury	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Liver Inflammation	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0
	Lower Respiratory Tract Infection	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Multiple Sclerosis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Neoplasm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
	Pain	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Respiratory Failure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	Seizures	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Sepsis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0
	Unknown	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upper Respiratory Tract Infection	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
	Urinary Tract Infection	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	3	0	0	1	0	0	0

3.3.3. Patient satisfaction and experience

Majority of patients were informed about their discharge by the medical doctors followed by nurses (Table 3.16). It must be noted that 7 patients (3.9%) in the intervention arm and 9 (5.1%) in the control arm reported that no-one had informed them of their discharge.

Table 3. 16: Provision of discharge information

Information about Discharge	Intervention n=265	Control n=265
Doctor n (%)	106 (58.9)	91 (51.4)
Nurse n (%)	50 (27.8)	53 (29.9)
Pharmacist n (%)	1 (0.6)	1 (0.6)
No One n (%)	7 (3.9)	9 (5.1)
Can't Remember n (%)	10 (5.6)	8 (4.5)
Doctor and Nurse n (%)	5 (2.8)	12 (6.8)
Doctor and Pharmacist n (%)	1 (0.6)	1 (0.6)
Doctor, Nurse and Pharmacist n (%)	0 (0)	2 (1.1)
Computer evaluation n (%)	85 (32.1)	88 (33.2)
Total	265	265

Table 3.17 shows that most patients had medication changes before discharge with more in the intervention group (n=100, 37.7%) compared to the control group (n=87, 32.8%).

Table 3. 17: Medication changes at discharge

Medication Changed	Intervention n=265	Control n=265	Total
No n (%)	79 (29.8)	87 (32.8)	166
Yes n (%)	100 (37.7)	87(32.8)	187
Unsure n (%)	1 (0.4)	3 (1.1)	4
Computer evaluation n (%)	85 (32.1)	88(33.2)	173
Total	265	265	530

Similar to information on discharge, medication counselling was also provided mainly by doctors and nurses (Table 3.18). It is concerning that some patients in the intervention arm (n=21, 7.9%) and the control arm (n=17, 6.4%) reported that they did not receive any medication counselling before discharge and that pharmacists only provided medication counselling to a total of 51 patients.

Table 3. 18: Medication counselling before discharge

Medication Counselling	Intervention n=265	Control n=265	Total
Doctor n (%)	24 (9.1)	23 (8.7)	47
Nurse n (%)	30 (11.3)	17 (6.4)	47
Pharmacist n (%)	21 (7.9)	30 (11.3)	51
No One n (%)	21 (7.9)	17 (6.4)	38
Can't Remember n (%)	0 (0)	1 (0.4)	1
Doctor and Nurse n (%)	73 (27.5)	87 (32.8)	160
Doctor and Pharmacist n (%)	1(0.4)	0 (0)	1
Nurse and Pharmacist n (%)	1 (0.4)	0 (0)	1
Unsure n (%)	8 (3.0)	2 (0.8)	10
Doctor, Nurse and Pharmacist n (%)	1 (0.4)	0 (0)	1
Computer evaluation n (%)	85 (32.1)	88 (33.2])	173
Total	265	265	530

Table 3.19 shows that more patients from the invention group reported having their medication changed (n=100, 55.6%) but not receiving medication counselling (n=21, 11.7%). In the control arm, 87 patients had their medication changed (49.2%) with 17 of them not receiving medication counselling (9.6%). More patients in the control group (n=22, 12.4%) than the intervention group (n=20, 11.1%) reported not receiving their discharge letter before being discharged. More patients from the intervention group (n=118, 65.6%) than the control group (n=113, 63.8%) reported expecting follow up appointments from CUH.

Table 3. 19: Patient reported information about discharge

Phone call feedback	**Intervention** **n=180**	**Control** **n=177**
Patient had medication changed n (%)	100 (55.6)	87 (49.2)
Patient did not receive medication counselling n (%)	21 (11.7)	17 (9.6)
Patient did not receive a discharge letter n (%)	20 (11.1)	22 (12.4)
Patient's discharge was not discussed n (%)	7 (3.9)	9 (5.1)
Patient expecting follow up appointments n (%)	118 (65.6)	113 (63.8)

The DA asked the patients who received the phone intervention how they were feeling on a rating scale of 1-5 with 1 being very poorly and 5 being excellent. Table 3.20 shows that the mean score for the intervention group of patients was slightly higher for the patients that were not readmitted within 30 days as compared to the patients that were readmitted with 30 days to CUH. The Chi-Squared (χ^2=4.472, p=0.484) test result showed a non-significant association between patient response to: How they feel? and readmission within 30 days (n=745+730=1475).

Table 3. 20: Mean scores of patients feeling response scale

"How are you feeling on scale of 1-5"	**No Readmission within 30 Days**	**Re-admission within 30 Days**
Mean score	3.39	3.17

Figure 3.2 below shows that the average confidence scores for both the control and intervention groups when the evaluation call was made were higher than the post discharge average confidence scores.

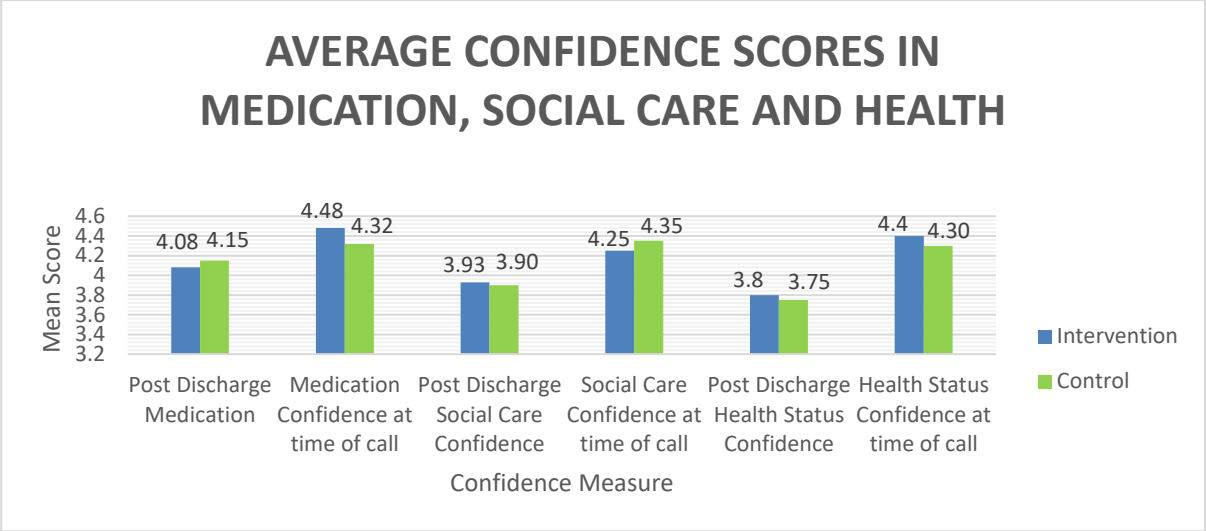

Figure 3. 2: Confidence in medication, social care and health status

The views of the patients regarding the DA call were solicited, most patients (n=168, 93.3%) reported that the purpose of the phone call was explained by the DA and that the timing (n=169, 93.9%) and the length of the call (175, 97.2%) were just right (Figure 3.3).

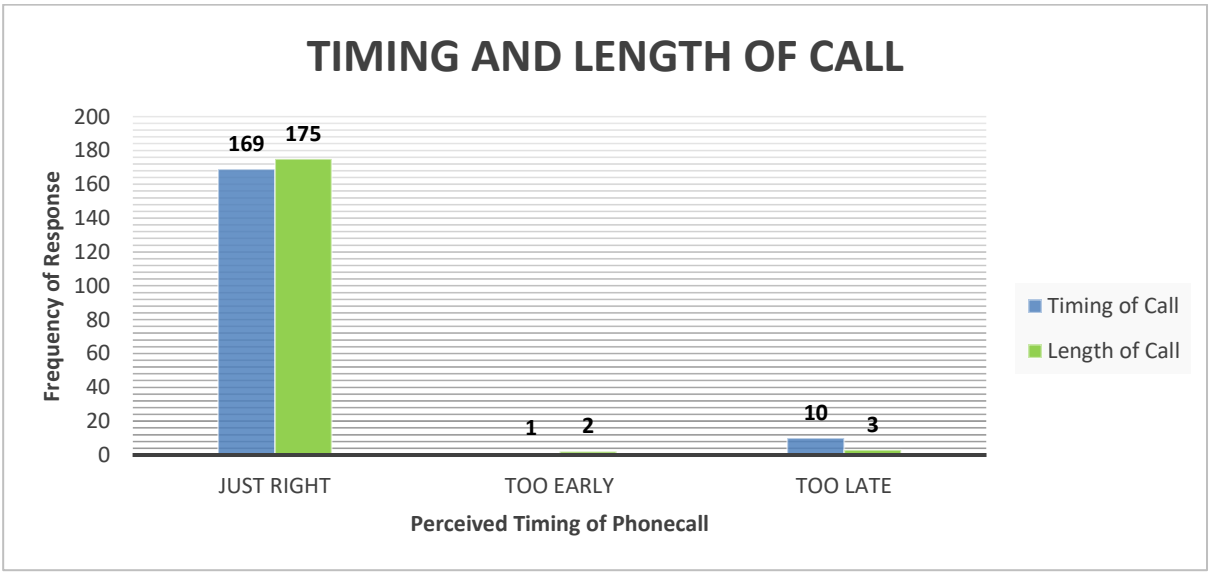

Figure 3. 3: Timing and length of the call

Actions taken by the DA whilst dealing with intervention patients over the study period included arranging appointments with: the GP (n=126), review in COPD Hot Clinic in 2

- 3 days (n=11), Red Cross to follow up (n=7), early OPD review by clinical discharge team (n=4), other social service to visit and add details to contact notes (n=3), elective appointments (n=3), Rapid Assessment Medical Unit (RAMU) Clinic in 2 - 3 days (n=2), local pharmacist for medicine management advice (n=2), occupational health to visit (n=2), Care of the Elderly to visit (n=1), physiotherapist to visit (n=1), review in Surgical Hot Clinic in 2 - 3 days (n=1), and the hospital avoidance team to visit in 1 - 2 days (n=1) (Figure 3.4).

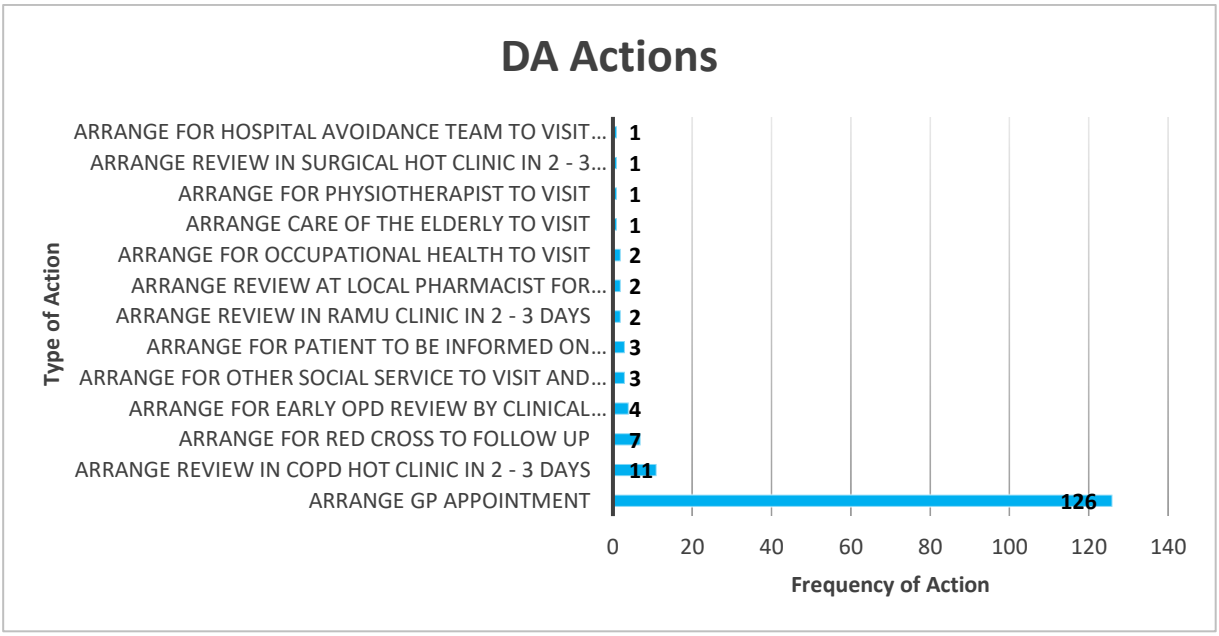

Figure 3. 4: DA Actions

Table 3.21 below shows that patients in both the intervention (n=114, 63.3%) and the control group (n=93, 52.5%) reported that they had made appointments for themselves after being discharged from hospital.

Table 3. 21: Appointments made by patients

External Appointments	Intervention n=180	Control n=177
No n (%)	65 (36.11)	82 (46.33)
Yes n (%)	114 (63.3)	93 (52.5)
Unsure n (%)	1 (0.6)	2 (1.1)

Table 3.22 below shows the intervention and control patients' responses when asked what type of appointments they had arranged post discharge. Both the intervention (n=96, 53.3%) and control patient (n=78, 44.1%) groups reported that they had made appointments to visit their GP after they were discharged from CUH. Some patients in

both the intervention (n=65, 36.1%) and control (n=63, 35%) groups indicated that they are still waiting confirmation of post discharge follow up appointments. It is worth noting that the highest frequency of appointments actioned by the DA for patients and by patients themselves was with the local GP. This may have been prompted by the phone call by the DA.

Table 3. 22: Patient made appointments post discharge

Type of External Appointments	Intervention n=180	Control n=177
Local General Practitioner n (%)	96 (53.3)	78 (44.1)
District Nurse n (%)	2 (1.1)	4 (2.3)
Pharmacist n (%)	2 (1.1)	4 (2.3)
Social Services n (%)	1 (0.6)	0
Doctor and Pharmacist n (%)	3 (1.7)	2 (1.1)
Doctor and referral to other hospital n (%)	10 (5.6)	7 (8.0)
Doctor and District Nurse n (%)	1 (0.6)	2 (1.1)
Doctor and Social Services n (%)	1 (0.6)	1 (0.6)

Figure 3.5 below shows that most patients (n=146, 81.1%) felt that the DA understood their healthcare needs.

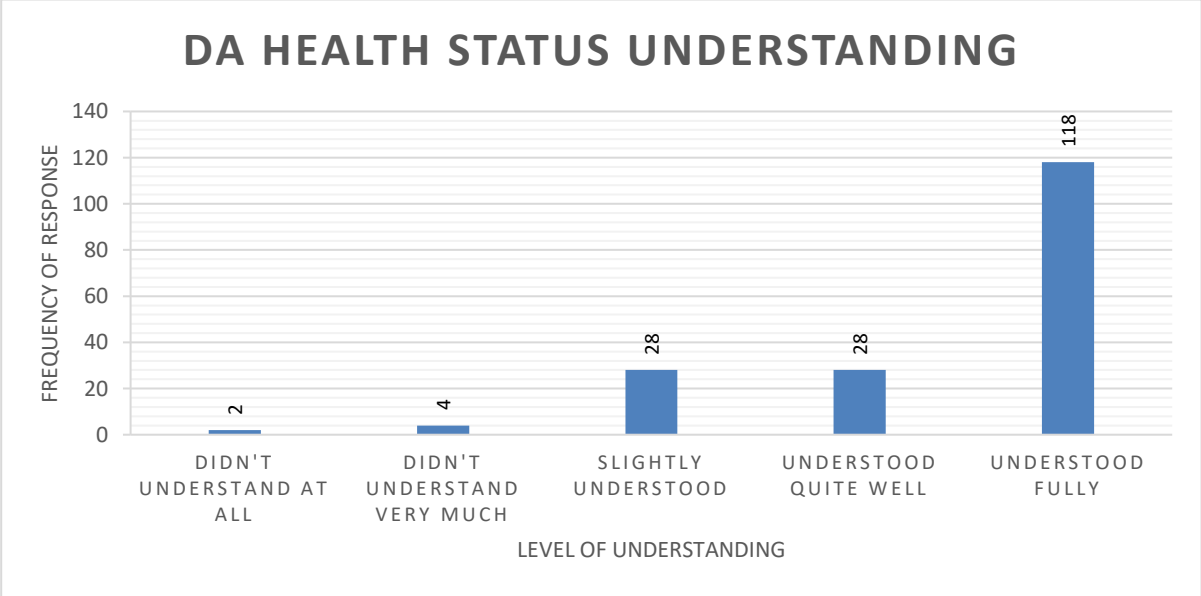

Figure 3. 5: DA Understanding of patients' health problems

Figure 3.6 below shows that most patients (n=148, 82.2%) felt that the DA was either helpful or very helpful.

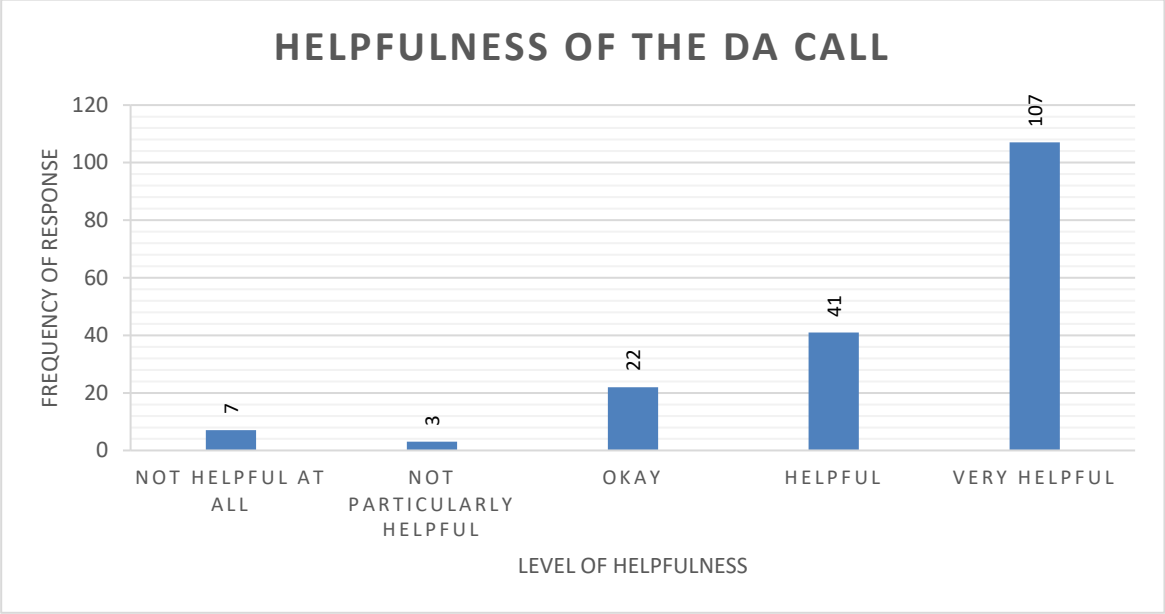

Figure 3. 6: Patient's perception of helpfulness of the DA call

Table 3.23 below shows that more patients from the intervention group (n=79, 43.9%) rated the support during their last discharge to be either better or lots better than their previous admission to CUH than the control group (n=42, 23.7%). The Chi-Squared test result (χ^2=8.083, p=0.232) showed a non-significant association between patient response to: How supported did you feel during this discharge? and readmission rate within 30 days.

Table 3. 23: Patient perceptions of previous discharge compared to their latest discharge

Support Rating Comparison	Intervention n=180	Control n=177
Lot worse n (%)	10 (5.6)	25 (14.1)
Worse n (%)	1 (0.6)	9 (5.1)
Same n (%)	39 (21.7)	75 (14.1)
Better n (%)	27 (15)	23 (13.0)
Lots better n (%)	52 (29.0)	19 (10.7)

When patients were asked if there was anything else that they would have liked to have discussed in the call with the DA, most respondents felt that the phone call was very

comprehensive and answered all their queries on their healthcare needs. Firstly, patients expressed that they felt surprised that the DA had kept the promise to call. On receiving the call, patients reported that it gave them a chance to ask questions that they did not get the opportunity to ask before discharge. Some patients reported feeling that their discharge process was too hasty, and it did not give them the chance to recuperate well enough to manage their care when they got home, and this resulted in other health care problems e.g. poor pain management. In these circumstances, patients expressed an even greater appreciation for the DA phone call as it gave them the opportunity to get the care that they required. Patients living alone also expressed similar appreciation for the DA phone call. Patients also reported that the DA phone call allowed them the opportunity to query follow up appointments from CUH that had not been confirmed and was pleasantly surprised that the DA was able to facilitate this. Some of the words of appreciation included: “Safe, cared for, helpful, reassured, improved my understanding of my care, thankful and not forgotten”. Most patients stated that the DA must continue to phone patients post discharge and that this is an essential service for patients not to get ‘lost in the system’. When asked whether there is anything else that they would like to comment on regarding their discharge, most patients stated that their expectation for discharge started when they were first informed about it by a healthcare professional in the hospital e.g. a doctor or a nurse. Common reason cited for delays in discharge included: poor communication between healthcare professionals, delays in finalising the discharge letter and delays in pharmacy delivering take home medication and porter availability. Patients found the time delay in discharge from being notified to being discharged unacceptable. Reasons cited for this included: inconveniencing family or friends to pick them up from hospital at the right time or having a taxi waiting to collect them. Most patients recommended that they should not be told that they will be discharged until the hospital has arranged everything needed to facilitate their discharge. This would avoid the disappointment and frustration experienced during the discharge process. Although the hospital is not a consumer business, patients seem to express the same level of expectation from the hospital as a consumer business especially with regards to the quality of the care that they receive and the importance of healthcare professionals keeping their promises. These are elements that patients have expressed that they value the most.

3.4. Discussion

This study aimed to evaluate patient satisfaction with the OPTIMAL discharge intervention and its effect on their discharge experience at CUH from September 2017 to June 2018. This study has revealed how study design methodology can affect the results of a study. Firstly, the randomised recruitment method resulted in patients with a low OPTIMAL readmission risk score mainly from AMU (n=246, 46.4%) being recruited into the study. This resulted in an inability to test the true effect of the intervention. The recruitment methodology also resulted in patients being recruited on more than one occasion into the study and did not safeguard against this. An underage patient from within the exclusion criteria was also recruited into the study. Lastly, human and system errors resulted in patients being recruited but not available to the DA as their information did not transfer from the hospital Cerner system to the OPTIMAL system. Despite the challenges faced in recruitment, 745 intervention and 730 control patients were recruited at CUH into the study from 5th June 2017 to 30 June 2018. Poor implementation and inadequate planning resulted in the unavailability of the SFT data which would have been supportive to meet the requirements of sample size (n=1700) as per the power calculation.

To achieve the aim, it was determined that at least 850 patients would need to be recruited into each group of which 265 would need to be evaluated. When trying to contact patients, difficulties in contacting patients affected the number of patients that could be evaluated telephonically. As the study progressed, the recruitment rate had decreased reducing the number of patients available for evaluation. Despite these challenges, 180 intervention and 177 control patients were successfully evaluated by phone call. This was partly achieved through a change from using a land-based line to contact patients to a mobile phone. This created the opportunity to leave a voicemail and a text message politely asking patients to contact the researcher at their convenience. The maximum landline patient contact rate was around 32% however, using a mobile device increased the success rate of patient contact to 92%. However, the low recruitment rate was still the main limiting factor and thus computer-based evaluations were performed on the patients that were not contactable by phone; 85 intervention and 88 control patients.

It is important to note that there was no significant difference in gender and age between the intervention and control groups both in the eligible and evaluated sample. The

evaluated sample had a shorter length of admission compared to the eligible sample, but this difference was not statistically significant. Similarly gender was not statistically significantly different. However the evaluated sample was statistically significantly different from the eligible sample in terms of age (p=0.022) with the evaluated sample having a higher age mean. The study identified that age is statistically significantly correlated with longer admission and higher risk of re-admissions.[152] This agrees with a 2020 UK study (n=137) that performed a significant regression analysis (F=0.04) on adult patients who had been admitted to CUH ≥2 times within 12 months (August 2014 to July 2015). The study reported age, as one of the variables significantly associated with >2 admissions in the previous 12 months (p=0.008).[152]

When comparing the intervention to the control group, it was noted that in the intervention and the control groups, the main reason for admission was infection, mainly pneumonia affecting 21 (7.9%) and 18 (6.8%) patients respectively. In the intervention group, sepsis (n=14, 5.3%) was also a main cause of infection whilst in the control group, urinary tract infections (n=13, 4.9%) were mostly prevalent. It was also noted that asthma (n=14, 5.3%) was a prevalent admission reason for the intervention group. Studies have reported these as potentially preventable reasons for readmissions and highlighted the resulting impact of inadequate community care of patients on early readmissions.[316]

One difference noted between the groups was that the mean OPTIMAL readmission percentage score was higher in the intervention (20.27) and control (20.91) evaluation groups than the intervention (15.95) and control (16.66) groups of the entire study. This difference in the OPTIMAL readmission percentage risk score between the eligible and evaluated sample was found to be statistically significantly different (p=0.001). The higher risk could be due to the higher mean age, as explained above, and potentially the shorter length of stay which may suggest a rushed discharge rather than a less serious medical problem as the reasons of admission were balanced across the groups.

Both the intervention and the control arms of this study had a higher OPTIMAL predictive score (15.95% and 16.6% respectively) and actual 30 day readmission rate (n=223, 15.12%), than reported by Billings et al.[337] (5.4%, PARR-30=readmission within 30 days) and the 2019 actual national (14.4%) and local (13.5%) NHS readmission data.[320] This proves the robustness of the OPTIMAL algorithm as the OPTIMAL predictive

readmission scores were closer to the actual readmission rate of the whole sample. In the sample tested, the OPTIMAL predictive percentage readmission scores were 20.27% and 20.91% in the evaluation and control arms compared to (n=61, 23%) actual 30 days readmission rate across both arms. Despite the higher OPTIMAL readmission score in the evaluation arms, the 30 day-readmission rate was statistically significantly lower in the evaluated sample compared to the whole sample (p=0.008). Furthermore, the percentage actual readmission rate was lowest for the intervention evaluation group (9.4%) as compared to the control evaluation group (13.5%) and this difference was statistically significantly (p<0.001). This outcome has been previously reported in a study that also offered 48 hour post-discharge nursing call and a GP home visit if needed where the intervention arm had a 9.24% 30-day readmission rate compared to 15.67% where no attempt to contact patients was made (p=0.011).[333] However, interventions with increasing complexity (multiple components) have been reported to be more successful in reducing readmission within 30 days.[332] This may explain why no reduction in readmission rate was observed in the intervention arm of the whole sample. This could also be explained by the fact that patients were not recruited based on their risk of admission using the OPTIMAL risk score but were randomly selected resulting in this being the first admission in the last 12 months for most patients. Nevertheless, the statistically significant reduction observed in readmission rate in the evaluated intervention arm suggests that the higher readmission risk scores can be a predictor of an intervention's ability to cause a reduction in the readmission rate regardless of its simplicity. Considering the cost of a GP visit (£37.40) is much cheaper than an emergency department admission (£45-£400) and ambulance transport (£252),[308] readmission risk prediction systems should be used to prevent early and emergency hospital admissions by making a follow up appointment with the GP post-discharge. Interestingly, on readmission, infection was still the main reason for readmission with sepsis and gastric inflammation being common to both the intervention and control groups. Again, on readmission, urinary tract infection was common in the control group.

Whilst most patients from the intervention and the control group reported receiving information about their discharge from doctor and nurses, few patients reported not receiving any information on discharge in both the intervention (n=7, 3.9%) and control (n=9, 5.1%) groups. Both the intervention (n=100, 37.7%) and the control groups (n=87,

32.8%) had medication changes, with 11% (n=38) across both arms not receiving medication counselling. Other studies have reported a lack of optimal medication counselling rate and content pre-discharge.[152,333] Duncan et al.[333] previously reported that medication advice was the most common intervention (n=75, 24.8%) required post discharge. It is concerning that the intervention group (n=100, 37.7%) had more medication changes before discharge than the control group (n=87, 32.8%) however the control group (n=30, 11.3%) reported receiving higher rate of counselling from the pharmacist (n=21, 7.9%) than the intervention group. However, overall the results indicate that pharmacists are not acting as the primary source of medication counselling with this being mainly delivered by doctors and nurses.

Some patients, 22 (12.4%) from the control and 20 (11.1%) from the intervention groups reported not receiving a discharge letter from the hospital. This letter contains important patient healthcare information on the treatment that the patient received in hospital and may be vital communication that is needed between different level of healthcare for future treatments e.g. hospital and local GP. The DA call was within 7 days of discharge and patients did report that the timing (n=169, 93.9%) and the length of the DA call (175, 97.2%) was just right. The study by Healthwatch England has highlighted that the highest amount of readmissions occur within 48 hours (29.2%) from discharge supporting the need for the DA call to take place 24-48 hours post discharge to support patients and prevent early readmissions.[319] The delay in the DA call in this study could be a potential reason for the lack of reduction observed in the readmission rate in the whole sample. The call by the researchers who were qualified pharmacists, may have contributed to the lower readmission rate observed in the evaluation arms.

The DA call was perceived positively by patients as they felt that the DA understood their health status (n=146, 81.1%) and was quite helpful (n=148, 82.2%). It is interesting that when the DA asked patients how they were feeling on a scale of 1-5 with 5 being excellent, intervention patients that were readmitted within 30 days had a lower average score (3.17) than those that were not readmitted (3.39). Overall, average confidence scores for medication, social care and health status were reported to be higher in both the intervention and control groups at the time of the evaluation call as compared to discharge. However, we cannot claim that the call from the DA had a direct effect on

average confidence scores for medication, social care and health status or whether this was due to the time that has lapsed post discharge. The DA most reported intervention as a result of their call was mainly to arrange a GP appointment for patients (n=126). Furthermore, both intervention (n-96, 53.3%) and control (n=78, 44.1%) group of patients indicated during the evaluation call that they arranged follow up appointments mainly with their GP. Duncan et. al.[333] has previously reported similar findings highlighting the need for community GP review of high readmission risk patients (n=66, 21.8%) post discharge. Overall, as expected, more patients from the intervention (n=79, 43.9%) than the control group (n=43, 23.7%) reported that they received more support during their last discharge as compared to their previous discharge from CUH. Responses to open-ended questions during evaluations revealed patients' service level expectations from CUH. Firstly, patients expected the staff at CUH to keep their promises e.g. ensuring follow up appointments are booked and getting the post-discharge call from the DA. This could provide a possible explanation as to why patients reported being pleasantly surprised when contacted by the DA. Secondly, patients expected CUH to operate an efficient discharge process and thus felt disappointed when they are informed that they will be discharged by their doctor but told that the hospital is not ready to discharge them due to outstanding tasks e.g. discharge letters and medication not being ready. Patients welcomed the DA call as it gave them an opportunity to discuss healthcare concerns that were not resolved post discharge and an opportunity to seek post discharge care.

Whilst the intervention was not successful, it was yet welcomed by patients. A recent systemic review and metanalysis indicated that more complex interventions are more successful in reducing readmission within 30 days.[332] This proposes that the intervention needs to be linked to multiple community-based interventions to be successful. Based on the findings of our evaluation, perhaps the intervention should not be offered to all but to those that will most benefit from it, so targeted intervention based on the OPTIMAL readmission risk score.

3.4.1. Limitations

This study was mainly limited by the application of the technology in a real-world environment. Despite several layers of pilot testing and enhanced versions of the system and questionnaires developed, several limitations arose in practice. Perhaps the most noted limitation was the human factor. Sherwood Forest had more DAs and was able to recruit patients at three times the rate of CUH but poor system implementation and data confidentiality limitations resulted in the data not being able to be used in this analysis. Again, the shortage of DAs at CUH was a call rate limiting factor and could have affected the readmission rates of both the intervention and control groups. Both researchers are pharmacists that would have prioritised the patient's healthcare needs above the study protocol e.g. during the phone evaluation of the DA call with the patient, if the patient expressed any additional healthcare needs, the researchers would have ensured that the necessary pharmaceutical care needs were responded to and the patient signposted as needed. This would have prevented future hospital readmissions.

3.4.2. Conclusions

Although OPTIMAL was unsuccessful in significantly reducing 30-day readmission, the results highlighted the following. Firstly, the shortage of DAs resulted in patients not being contacted at the optimal time to offer a meaningful intervention. Secondly, the ability of OPTIMAL to significantly reduce 30-day readmission was influenced by the higher risk of the recruited patients. There seems to be an optimal risk range of patients that would benefit from the post discharge intervention. Lastly, patients valued the post discharge intervention and felt supported. Even though the evaluated group had a higher mean percentage OPTIMAL risk score for 30-day readmissions than the study group, the dual layer intervention offered by the DAs and researchers resulted in the lowest 30-day readmission rate in this group, supporting the need of a multi-layer intervention. Overall, there is potential to use OPTIMAL to reduce the 30-day readmission rate if these shortcomings are considered before implementation.

3.5. Author Contributions

Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND	✓
Drafting the work or revising it critically for important intellectual content; AND	✓
Final approval of the version to be published; AND	In progress
Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.	✓

Chapter 4: The Physicians Ear

4.1. Background

Congenital heart disease refers to defects in the structure of the heart and major blood vessels which are present at birth. There are many forms of congenital heart disease most of which obstruct or disturb the flow of blood through the heart e.g. heart murmurs which present as the first sign of pathological changes of the heart valves.[345] In the UK, around 1 in 180 babies are born with congenital heart disease.[346] One study suggested that 54% of murmurs detected have an underlying cardiac malformation.[347] Whilst innocent systolic murmurs have been detected in up to 72% of the new-born children,[348] only 30 to 45% of general practitioners have adequate paediatric experience resulting in a large number of cases being inappropriately referred to the paediatric department for investigation and discharge.[349] A UK national audit has reported that the antenatal diagnostic rate of congenital heart disease has increased from 2008 (n=1828, 28.8%) to 2017 (n=1590, 53.5%).[350] Early detection and treatment of congenital heart disease can help to reduce morbidity and mortality rates however, detection and interpretation of murmurs is highly dependent on skill and experience.[347,351,352] The ability of TH to remotely monitor and share a patient's health status offers the potential benefit of early diagnosis of cardiac murmurs.[18,70,353]

This chapter will aid the reader to understand the antenatal and paediatric cardiovascular system and pathological changes that occur in congenital heart disease. Diagnostic techniques and treatments available are described within the current NHS care pathway. The potential of using an electronic stethoscope to add value to the current NHS diagnostic care pathway for paediatric patients with congenital cardiac defects is investigated using analytical, quantitative, and qualitative techniques. This methodology also allowed for the researcher to test the potential of using an electronic stethoscope to remotely confirm a diagnosis and make recommendations for more efficient and effective diagnostic care pathways for paediatric patients with congenital cardiac defects.

4.1.1. Foetal Antenatal and Paediatric Postnatal Cardiac Circulation

Figure 4.1. shows that the foetal cardiovascular system is completely formed by 9 weeks and 50% of the blood is in the placenta and 50% in the foetus.[354] In the foetus, oxygen rich blood (SpO_2=80%) travels from the placenta through the umbilical vein, ductus venous sphincter and mixes with deoxygenated blood from the inferior vena cava to flow towards the patent foramen ovale (PFO).[354,355] At the PFO (septum primum and septum secundum), 25% of the oxygen rich blood enters the right atrium and mixes with deoxygenated blood from the superior vena cava (head and arms).[354,355] Some blood remains in the right atrium due to the crista dividens whilst the remaining blood flows through tricuspid valve to the right ventricle that contracts to pump blood through the pulmonary arch into the pulmonary arteries (10%) and ductus arteriosus.[354,355] Most of the blood (75%) from the inferior vena cava enters the left atrium and flows through the aortic valve into the left ventricle and 60% of this highly oxygenated blood flows through to the ascending aorta to the coronary (cardiac muscles), carotid arteries (brain) whilst the remaining 40% of low oxygenated blood (SpO_2=58%) flows through the descending aorta to the umbilical arteries.[354,355] The right ventricle (65%) contributes more than the left ventricle (35%) towards the systemic cardiac output and blood flows from right to left.[354] Foetal pulmonary vessel resistance is high and results in blood flowing through the patent ductus arteriosus (PDA) into the descending aorta and mixing with blood from the proximal aorta.[354,355]

Figure 4.1. shows that after birth, the cutting of the umbilical vein stops placental blood flow and reduces blood flow and pressure to the right atrium resulting the closure of the PFO.[355] The closure of the PFO occurs when the septum primum becomes apposed to the septum secundum during the first few breaths reducing the volume of blood in the right atrium and reversing the direction of atrial blood flow.[354,355] Crying creates a shunt and blood flows from right to left and presents as cyanosis in neonates however, the narrowing of the PFO results in left to right blood flow and septal fusion is supposed to occur within the first year from birth.[354,355] The first breaths also cause the release of the prostaglandin bradykinin which results in apoptosis of smooth muscle and proliferation of connective tissue of the ductus arteriosus, closing the PDA.[354,355] Closure of the ductus venosus sphincter and umbilical arteries and veins prevent sudden volume overloading in the heart.[355] The required changes in cardiac biological structures and

blood flow from antenatal to post-natal predisposes neonates to developing cardiac murmurs.

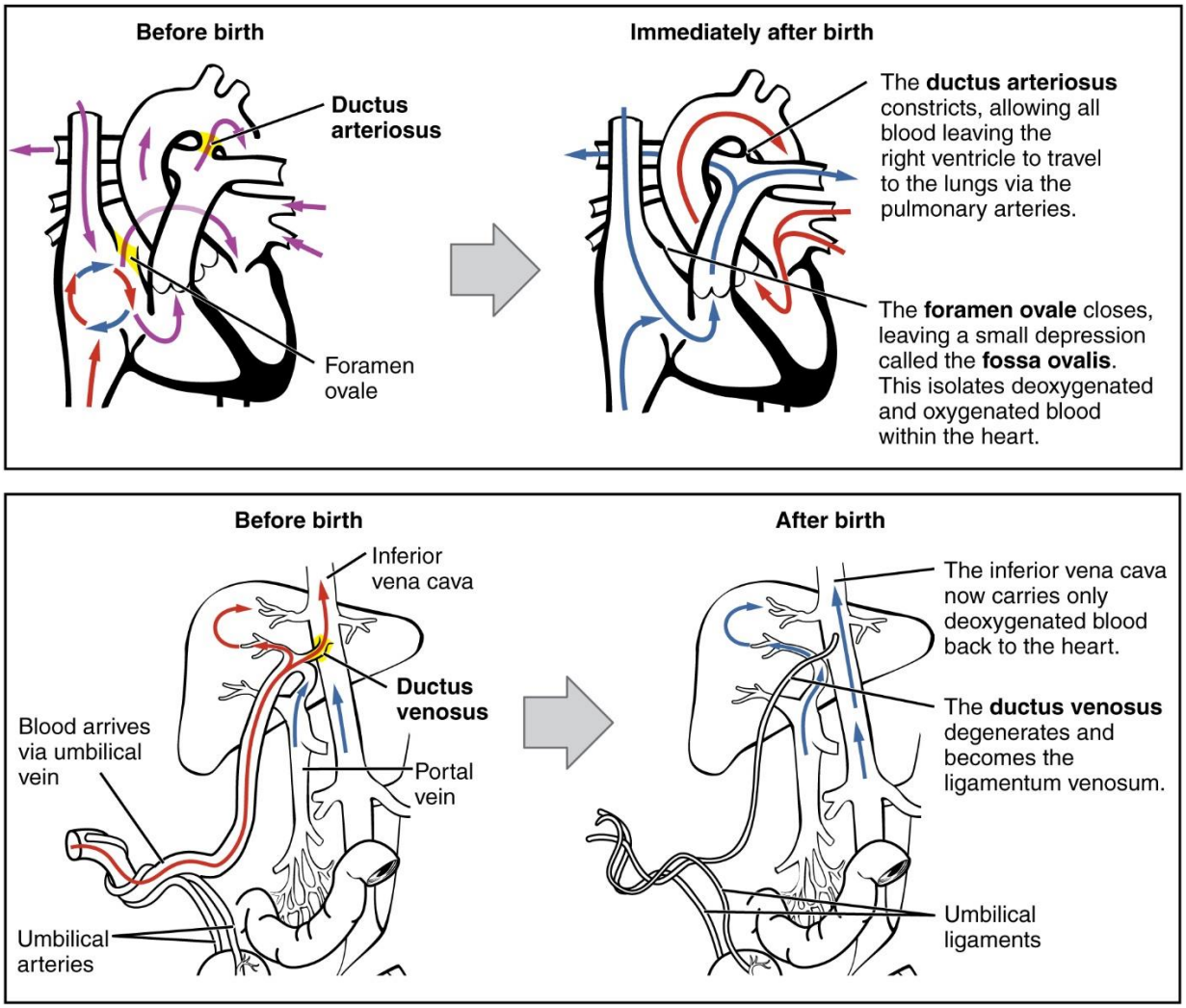

Figure 4. 1: Cardiac Circulation: Foetal Antenatal and Paediatric Postnatal[356]

4.1.2. Normal Cardiac Structure and Circulation: Timing and Sounds

Figure 4.2. shows that the heart is a four chambered muscular pump that consists of two ventricles that pump the blood and two atria that assist in ventricle filling with four valves (semilunar= pulmonary and aortic and atrioventricular= tricuspid and mitral) that maintain unidirectional flow of blood.[357,358] The atrioventricular valves are kept in place by the fine cords called chordae tendineae that connect the valve cusps to the ventricular papillary muscles. The aortic/pulmonary semilunar and tricuspid atrioventricular valves have three cusps whilst the mitral valve has two cusps which

meet to seal.[357] The time during ventricle contraction is known as systole and the refill time of the heart is called diastole.[357,358]

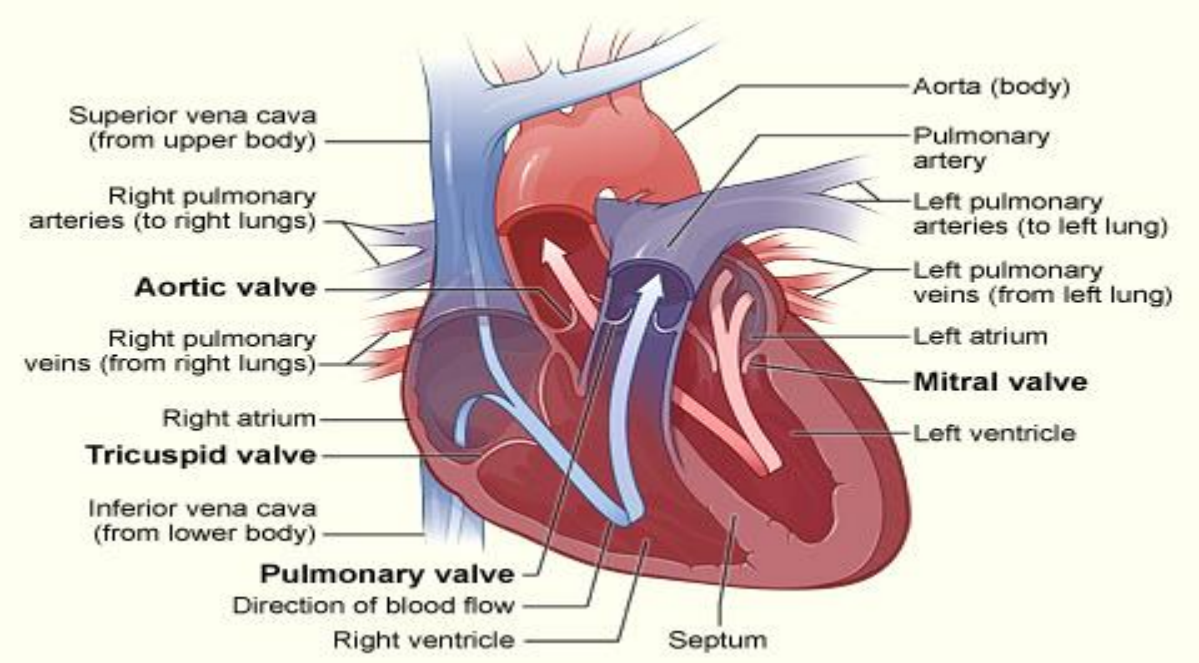

Figure 4. 2: Cardiac Structure [359]

The cardiac cycle (Figure 4.3) starts at the end of diastole with the pressure in the atria, aortic and pulmonary artery greater than ventricular pressure resulting in the opening of the atrioventricular valves and the closing of the semilunar valves.[357,358] Atrial systole results in atrial contraction followed by isometric volume contraction during which both the atrioventricular and semilunar valves are closed.[357,358] When the ventricular pressure is higher than the aortic or pulmonary artery pressure during systole, the atrioventricular valves close causing a small atrial pressure wave (S1 = 'Lub') and semilunar valves open allowing the ejection of blood through the aortic semilunar valve into the aorta and through the pulmonary semilunar valve into the pulmonary artery towards the lungs to increase the oxygen saturation of blood.[357,358] The ventricles stop contracting on the latter period of the systolic ejection phase and blood continues to eject the ventricles due to momentum until the reversal causes closure of the semilunar valves and a small increase in aortic pressure and a second heart sound occurs (S2 = 'Dub') due to reverberation in the blood.[357,358] The time interval between S1 and S2 is the systole, while the gap between S2 and the next S1 corresponds to the diastole. The

time for systole is always less than the time for diastole and at rest is half the duration of diastole.[357,358]

Diastole begins with closure of the semilunar and atrioventricular valves during isovolumetric ventricular relaxation.[357,358] The pressure in the atria increases due to blood filling whilst the ventricular pressure decreases due to elastic recoil causing the opening of the atrioventricular valves and a rapid decline in atrial pressure.[357,358] The right atrium fills the right ventricle through the tricuspid atrioventricular valve with oxygen poor blood and the pulmonary veins carry oxygen rich blood to the left atrium which fills the left ventricle via the mitral atrioventricular valve ending diastole and beginning the cardiac cycle.[357,358]

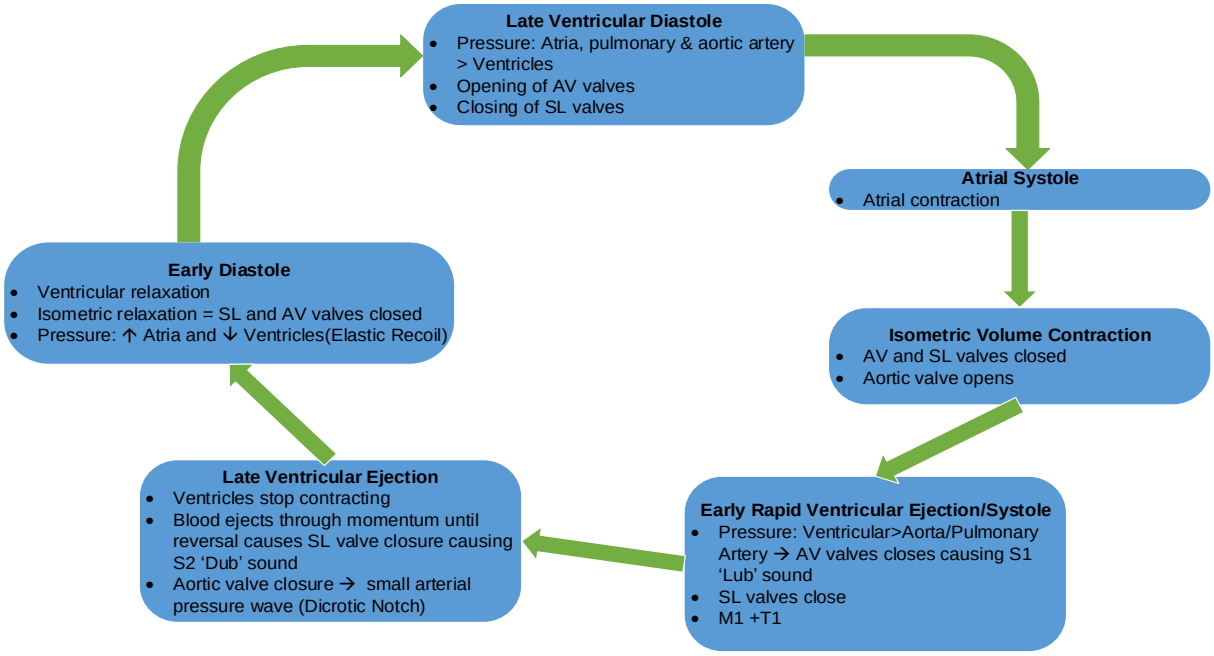

Figure 4. 3: The Cardiac Cycle

4.1.3. Cardiac Auscultation, Diagnostic Equipment and Software

Cardiac murmurs are detected through auscultation and confirmed using echocardiography.[360,361] Listening to the body for clues to health and disease was not systematically explored for 2200 years between the time of Hippocrates and Laennec (inventor of the stethoscope).[362] About 300 years ago, Robert Hooke wrote: "I have been able to hear very plainly the beating of a man's heart. Who knows, I say, but that it may be possible to discover the motions of the internal parts and bodies by the sound that they make, that one may discover the works performed in the several offices and shops

of a man's body, and thereby discover what instrument or engine is out of order".[363] Both electrocardiography and phonocardiography started around the same time and play an important role in the training of the sense of hearing to be able to precisely identify time relations between sound patterns and events in the cardiac cycle.[362] In 1963, Segall [362] recommended that we must record notes and sounds heard as the educated human ear is able to pick up murmurs with a stethoscope but retention is not permanent and that a record is an essential component of clinical auscultation. A high degree of accuracy in recording will result in the attainment of an equally high degree of listening. Segall [362] recognised that the knowledge in this area was incomplete and that better instruments for monitoring the mechanical events of the heart and recording the heart sounds and murmurs was needed.[362] McKusick's stated in his book 'Cardiovascular Sound' in 1958; "In recording the findings of auscultations, a crude diagram can be worth a thousand words".[364] Laennec invented a monoaural stethoscope in 1816 by rolling a piece of paper into a tube and placing one end on a large breasted patient's chest and the other end to his ear to be able to hear sounds much better than he could hear with his bare ear.[365] A binaural stethoscope was developed by George B. Camman of New York in 1855.[365] The chest piece was a bell until Bazzi and Bianchi [366] introduced the phonendoscope in 1890 and the M. Bowles [364] introduced the bowles diaphragm in 1894. Low pitched murmurs e.g. mitral stenosis is better heard with a bell chest piece whereas high pitched murmurs e.g. aortic insufficiency is better heard with a diaphragm chest piece. A combination chest piece was developed by Dr Howard B. Sprague in 1926 as seen in Figure 4.4.[367]

Figure 4. 4: Analogue (Left) and Electronic (Right) Stethoscopes[368,369]

Heart sounds are detected on specific points on the chest as seen in Figure 4.5. Placing the chest piece in different areas allows the detection of different sounds as blood flows through the heart. The recommended areas for listening to heart sounds includes the aortic area that is located at the 2nd intercostal right space, the pulmonic area that is located at the 2nd left intercostal space on the sternal border, the left sternal border that is located on the 3rd left intercostal space on the sternal border, the tricuspid area that is located on the 4th left intercostal space on the sternal border and the mitral area that is located towards the apex of the 5th left intercostal space tending towards the sternal edge.[370] Diagnosis and types of common congenital murmurs are discussed in the next section.

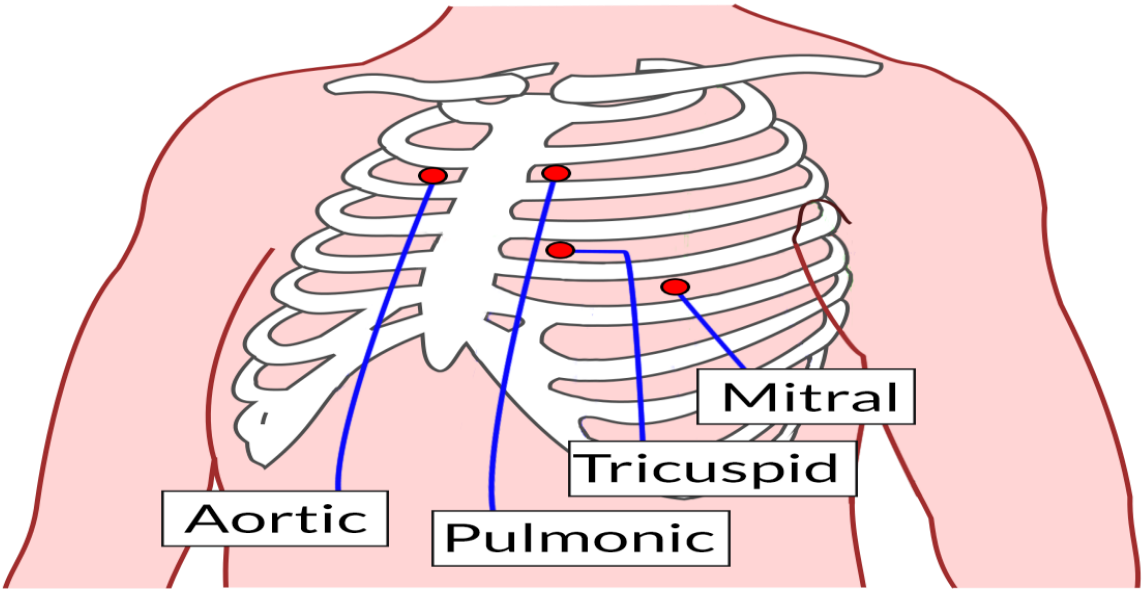

Figure 4. 5: Auscultation Areas[371]

Echocardiography has been established as an integral tool in the diagnosis of cardiovascular abnormalities both antenatally and postnatally.[361,372,373] Echocardiograms use high frequency sound waves that are emitted from a transducer through ultrasonic transmission gel on the body surface and the reflection of the waves is captured to form an image.[361,372,373] Echocardiograms are used to diagnose various cardiac abnormalities as it has the ability to measure blood flow velocity, valve structure,

pressure gradients across valves, ventricle and atrial size, rhythm disturbances and doppler flow through arteries and veins.[361,372,373] The measurement of specific pressure differences has been reported to be used in diagnosis and is also common practice e.g. pulmonary valve (10 mmHg), septal defects causing chamber dilation and pulmonary stenosis if the difference in peak flow between the right/left pulmonary artery and the main pulmonary artery was greater than 50%.[361,372,373] The short axis view (Figure 4.6) allows visualisation of all four heart chambers including the atria and ventricles, the atrioventricular valves, and the atrial and ventricular septa and can be used to identify congenital abnormalities e.g. an enlarged ventricle or a septal defect.[374]

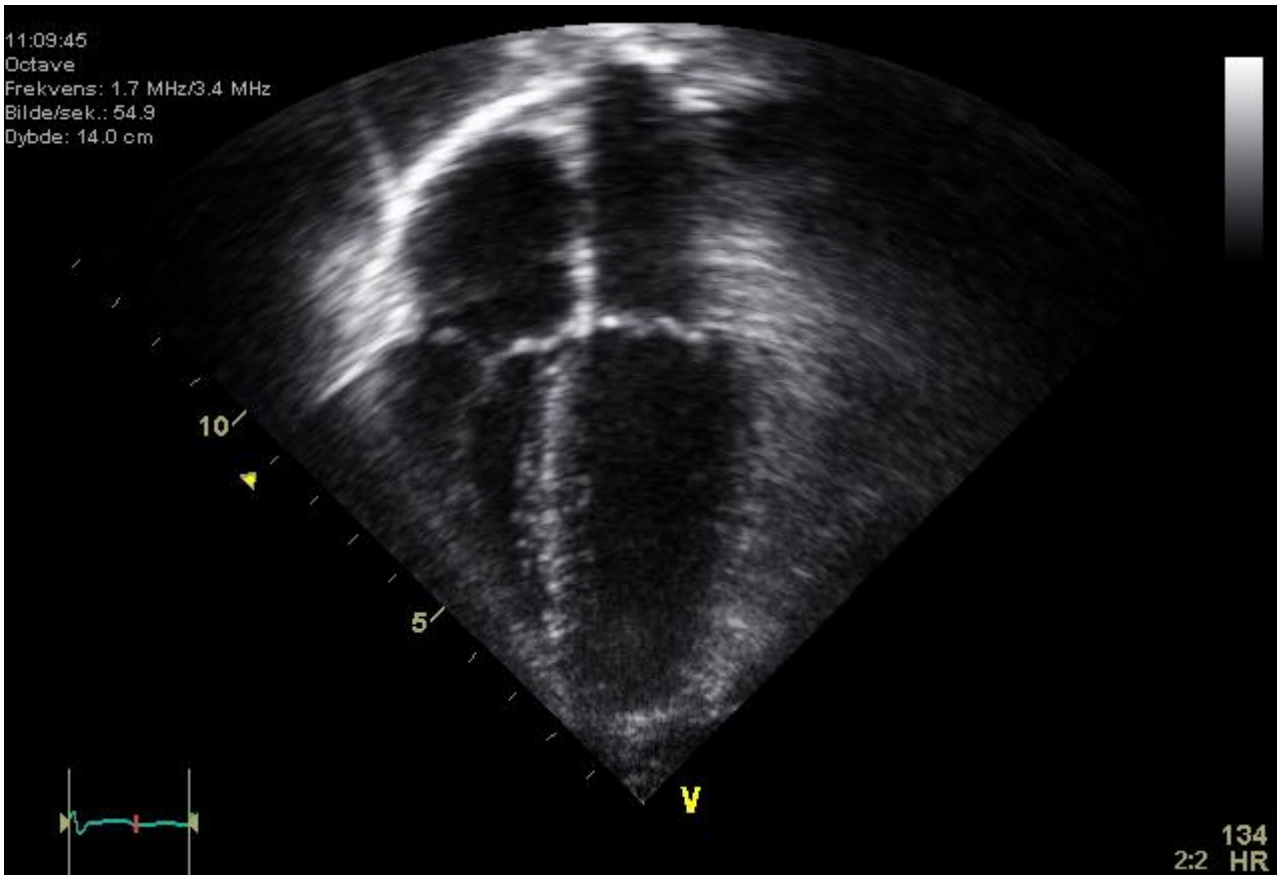

Figure 4. 6: Echocardiogram of the four-chambers of a heart[375]

Snider [372] has recommended a colour doppler echocardiography ultrasound techniques (Figure 4.7) as they allow the visualisation of blood flow across septa and can help diagnose congenital cardiac septal defects e.g. atrial septal defects (ASD).

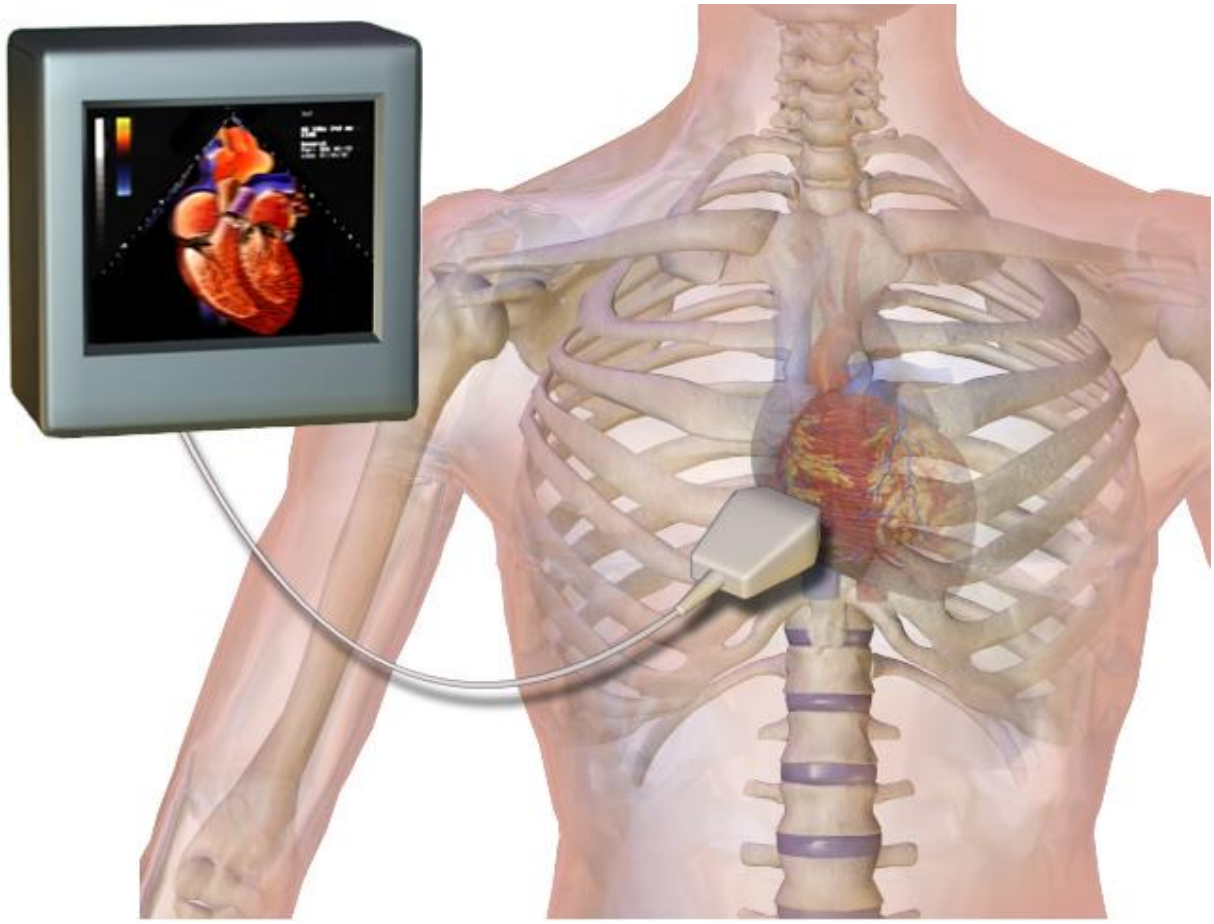

Figure 4. 7: Colour Doppler Echocardiography[376]

4.1.4. Cardiac Murmurs

Cardiac murmurs are sounds created as blood flows across the heart valves and can be physiological thus do not require intervention or pathological which require further investigation.[358] Figure 4.8 shows the pathological murmurs that require further intervention as heart valves may be leaky, stenotic or regurgitating and can be systolic, diastolic or continuous in timing.[358] Systolic murmurs can be caused due to regurgitation (mitral or tricuspid), stenosis (aortic and pulmonary), septal and flow defects whilst diastolic murmurs can be caused due to regurgitation (aortic and pulmonary) and stenosis (mitral or tricuspid).[358] Continuous murmurs can be caused due to PDA, narrowing of the aorta and severe aortic regurgitation.

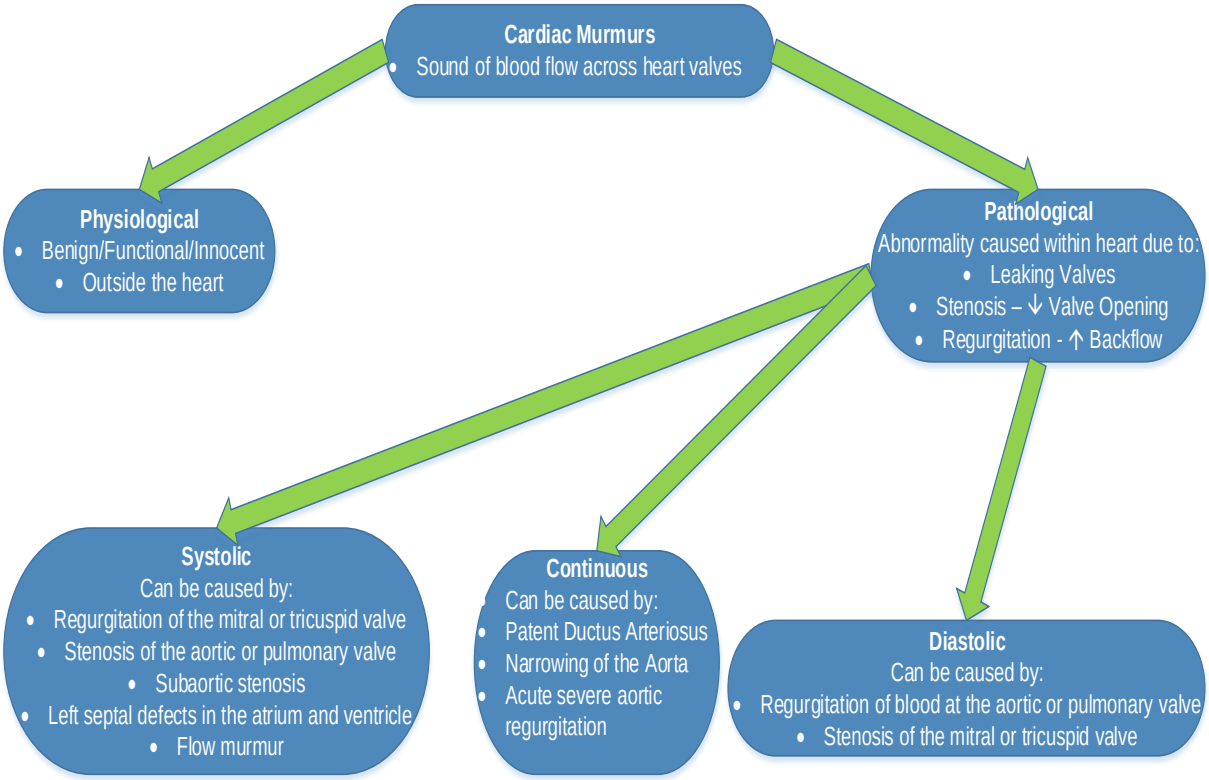

Figure 4. 8: Paediatric Murmurs [358]

Murmurs can be characterised by pneumonic 'SCRIPT' which includes the location (site), sound configuration, direction of blood flow (radiation), loudness of the sound (intensity), pitch and timing of the sound.[358] Murmurs can be located in the second right (aortic) intercostal space or the second left (pulmonic) intercostal space or the fourth left (tricuspid) intercostal space or the fifth left (mitral) intercoastal space (see section 4.1.3).[358] The sound configuration of murmurs can be described as gradually getting louder (crescendo), gradually getting softer (decrescendo) or starting louder and then getting softer (crescendo-decrescendo).[358] The loudness (intensity) of the murmur is often described using a numeric scale (Levine): 1= Listen carefully for some time, 2= Faint and immediately audible, 3= Loud murmur, no palpable thrill, 4= Loud murmur with a palpable thrill, 5= Loud murmur with palpable thrill detected with the rim of the stethoscope and 6= Loud murmur with palpable thrill detected by lifting the stethoscope just above the chest.[358] The pitch of the sound can be described as low, medium or high and quality that is, blowing, harsh, rumbling or musical and murmurs can occur during systole or diastole (timing).[358] Depending on the timing of the murmur, pathological murmurs can be systolic, diastolic or continuous.[358]

4.1.5. Cardiac Telehealth Applications

In 1903, Einthoven used a string galvanometer to record the electrocardiogram of a patient in hospital two miles away from his laboratory and in 1907 he recorded an electrophonocardiogram displaying first, second and third heart sounds in a normal patient.[377] A study compared the evaluation of 21 children by a remote paediatric cardiologist using a 768-Kbps telemedicine system to a local paediatric cardiologist (normal face to face examination).[378] The remote paediatric cardiologist was able to successfully diagnose 19 of 21 (91%) children but missed ventral septal defects in 2 (9%) children.[378] There was no significant difference in additional tests e.g. ECG and ECHO requested by both paediatric cardiologists and this study concluded that telemedicine is a useful tool for cardiac evaluation of paediatric patients.[378] Another study has emailed the heart sounds of 47 children [no murmur (n= 7), with innocent murmurs (n= 20) and pathological murmurs (n= 20)] using as sensor based stethoscope to four cardiologists for assessment.[379] Cardiologists scored a mean sensitivity (89.7%) and specificity (98.2%) and their interobserver (kappa=0.81) and intraobserver (kappa= 0.87) variabilities were low.[379] This study therefore concluded that remote assessment of innocent murmurs by a cardiologist is safe and time saving.[379]

Another study has compared using an electronic stethoscope (Littmann® Model 3200, 3M™); to a traditional stethoscope to develop cardiac auscultation skills of undergraduate medical students (n=38) over eight weeks.[380] Students were separated into two groups: electronic stethoscope (n=21) and traditional stethoscope (n=17) and the students using the electronic stethoscope showed significantly greater improvements (51.9%) as compared to the students using the traditional stethoscope (29.5%) and thus concluded that an electronic stethoscope is useful to aid teaching of clinical cardiac auscultation skills of undergraduate medical students.[380]

A study recorded the electrocardiograms and heart sounds (using an electronic stethoscope) of 300 children (age range=1 month to 17 years, median=5.5 years) and analysed sounds using a digital algorithm to detect the R-wave/S1/systole (100%) and T-wave/S2/diastole (97%) phases successfully.[381] Other outcomes of this study included segmenting the sound file (from S1 to S2) to quantify (maximum and range) the frequency at the maximum intensity of the murmur and its time from the first heart sound (S1).[380]

In May 2019, the Food and Drug Administration (FDA), has approved an artificial intelligence (AI) heart murmur detection mobile/cloud application called “eMurmur ID” that uses the 3M™Littmann® Model 3200 stethoscope to identify and classify pathologic and innocent heart murmurs, the absence of a heart murmur, and S1, S2 heart sounds.[382] This platform has reported an 89% algorithm’s sensitivity (CI: 78 to 96%) for autonomous detection of pathologic murmurs with two of the six false negatives detected as innocent murmurs and no murmur detected in the remaining audio files.[383] These false negatives were diagnosed by the cardiologist as medium and four as low severity with no high severity cases missed by the algorithm.[383]

4.1.6. Rationale

The drive for research into automated analysis of heart sounds has arisen from the historic lack of improvement in stethoscopes, limitations of the human ear and the improvement in data recording and digital sound processing techniques.[384–393]

The ear is unable to analyse the entire acoustic spectrum of heart sounds.[387] The ear is able to better hear changes in frequency than frequency per se as it uses a logarithmic scale as thus higher frequency (pitch) sounds could be erroneously interpreted as more intense (louder) than lower frequency sounds.[381] The ear may not identify low frequency sounds that immediately follow high frequency sounds.[388] A European systematic review has reported that 30% of men and 20% of women were found to have a hearing loss (HL) of 30 dB HL or more by age 70 years and 55% of men and 45% of women by age 80 years.[386] Presbycusis is the gradual age-related sensorineural HL that initially affects the ability to hear high frequency (pitch) sounds and it has been reported that older men have a greater high frequency HL and slightly less low-frequency HL as compared with older women e.g. above 1 kHz males show greater average loss than females, but below 1 kHz females show greater average loss than males.[394–396] Whilst the accuracy of congenital heart murmur diagnostic rate of clinicians should improve as their experience increases over time, clinicians are also challenged with hearing loss as they age.

Auscultation findings are easier to discern at a slow heart rate and it is harder to examine in a child as they have faster heart rates and might be moving or crying.[397] Detection of

a murmur depends on a physician's skills, experience, confidence level, timing, frequency, and conditions of examination. Frequency of detection averages around 44% and diagnostic accuracy varies between 33% to 96%.[347,397–399] Other studies of internal and family medicine residents have demonstrated less than optimal clinical auscultation skills with diagnostic accuracies ranging even lower from 20% to 54%. A study has found that 69% of patients referred by paediatricians to paediatric cardiologists had an inaccurate referral diagnosis and only 30% of patients referred were found to have a definitive or possible underlying heart disease.[399]

Clinicians are faced daily with the decision on whether to refer a patient for evaluation of a heart murmur. All new-born infants need to have a medical examination, including auscultation of the heart, before being discharged home. As many as 50-70% of asymptomatic children with a murmur referred for specialist evaluation or echocardiography have no heart disease, that is, type-I or false positive error. A type-II error or false negative occurs when a neonate with a pathological murmur is sent home without treatment.[345,400] Positive predictive value (PPV) is the probability that paediatric patients with a positive screening test truly have a murmur.[401] Negative predictive value (NPV) is the probability that paediatric patients with a negative screening test truly don't have a murmur.[401] Due to inexperience of junior (medical and midwifery) staff performing the pre-discharge auscultation, several lesions are being referred onwards or not being referred when needed.[345,399,400]

4.2. Aim and Objectives

This study aimed to evaluate the feasibility of the use of an electronic stethoscope for the detection of heart murmurs in the NHS. In order to achieve this aim, the following objectives were set:

- To acquire and compile a database of heart sounds from paediatric patients using an electronic stethoscope. This database of heart sound recordings would then be used to:
- To develop and apply methods to investigate and analyse heart sounds of paediatric patients.
    - To compare the waveforms of heart sounds from infants where murmurs were detected to waveforms of heart sounds from infants with no discernible murmur.
    - To investigate the ability of clinicians to retrospectively identify heart sounds in both local general and remote specialised hospitals settings.
- To evaluate the usability of an electronic stethoscope and associated software amongst clinicians with different levels of experience.

4.3. Methodology

4.3.1. Detection and acquisition of heart sounds of paediatric patients

All patients referred to the visiting Consultant Paediatric Cardiologist supervised clinics at CUH were reviewed by a CUH Consultant Paediatrician with an interest in paediatric cardiology. The patient list for five Consultant Paediatric Cardiologist supervised clinics at CUH Willow Outpatient Department (OPD)ward was obtained in advance of each clinic during the study period (April-November 2016). Participants medical history was pre-screened using hospital files, Cerner® (CUH clinical patient management software) and CVIS (Echo and ECG reporting software). Parents or the legal guardians were approached on arrival of their appointment at CUH Willow OPD cardiac clinic. The purpose of the study using the patient information leaflet (Appendix 22) and consent form (Appendix 24) was explained verbally and then parents or legal guardians were provided with a patient information leaflet and a consent form to complete if the patient or legal guardian wanted to consent to participate in the study. Consent for retention of the sound files for education and training purposes was also sought and maintained in accordance with the participant wishes as indicated on the consent form. If consent for the sound recording storage was declined, then recordings were destroyed after analysis. After written consent, participant numbers were assigned sequentially as each participant entered in the study and were indicated on the consent form as per Data Protection Act 1998.[402]

The Clinical Record Form (Appendix 24) was then used to record the date of birth, gender, height, weight, and participant's number. Source documents of participants included hospital records, clinical and office charts, laboratory and pharmacy records, diaries, radiographs, dictations, and correspondence. All documents and auditory data were stored safely according to NHS data protection standards: encrypted onto password protected computer systems in NHS secure offices. All study data was entered on an Excel 2010® spreadsheet and encrypted using a password function in Excel®. Excel® files were encrypted using WinRAR® compression software providing AES with a key of 256 bits. This study was approved by SEC Research Ethics Committee (REC) at Kingston University (1314/042) and R&D department as a service evaluation and feasibility study. This study did not meet the NRES criteria and therefore did not need formal IRAS approval as there was no randomisation of groups, there was

no change in care from currently acceptable standards and findings were not generalizable.

Heart sounds were recorded using a Littmann Model 3200 Electronic Stethoscope (3M®, USA). For the recording to take place, the participant was in a quiet room without excessive background noise. They were either sitting down on the couch on a seat such that the upper body is 45 – 70 degrees to the horizontal. The upper chest was then exposed. The recording end of the stethoscope was cleaned with an alcohol swab and warmed to body temperature. The instrument was switched on to record in the extended mode (the entire blacked out icon is then displayed). Amplification setting was set at 3. The stethoscope was then placed onto the patient's chest at the aortic point and a 30 second recording was taken. Once completed the stethoscope was removed and the track changed to the next track and a 30 second recording is made with the stethoscope head placed at the pulmonic point. This process was repeated for ERB's point, the tricuspid and mitral points (Figure 4.5). Participants that did not tolerate being placed onto the couch or seat were auscultated either standing or in their parent's lap to avoid undue distress. Participants that were not able to stand or sit (e.g., under 1 years of age) were auscultated whilst lying on their backs. Participants may have had recordings on separate occasions if they visited a subsequent cardiac clinic. There was no loss or change in patient management whether they participated or not. Participants with a murmur had their chest exposed for 1 to 3 minutes longer than non-participants whilst the device was placed on their chest for recording of heart sounds. There were no other perceived risks for participants. The recordings were transmitted using Bluetooth technology into 3M's Littmann StethAssist® software to create the original sound file format, that is *.zsa containing the date, time, and location of each recording and unique participant identification number embedded within the file. A Consultant Paediatrician (PI) reviewed all recordings.

All participants suspected of or having any cardiac malformations were referred for an echocardiogram. The results of an echocardiogram are regarded as the 'gold standard' and thus was used to validate the accuracy of heart sound recordings. The correct diagnosis was validated by a paediatric cardiologist and supported by echocardiogram results.[403] Age-matched participants with an absence of a murmur and no known cardiac malformation (≤1-year-old within 2 months and >1-year-old within 6 months) were then recruited as part of the control group. The clinical history of age-matched participants

was reviewed on Cerner® and the heart sound recordings were also reviewed by a Consultant Paediatrician. Participants were excluded from the study if the participant had a history of, or is due for cardiac surgery (6 months) for a cardiac condition e.g. Tetralogy of Fallot or aortic coarctation, receiving medication for cardiovascular treatment e.g. off-label use of lisinopril as these criteria would change characteristics of the sound recording. The number of patients recruited from those that attended the clinics (n=87) during this study was 72 patients (82.8%). The heart sound recordings of paediatric patients were used to compile a database and associated software was used in five different studies with different methodologies:

4.3.1.1. To develop and apply methods to investigate and analyse heart sounds of paediatric patients

Heart sounds from six children with murmurs and from six children with no known heart disease were selected from the database of recordings. A Consultant Paediatrician reviewed sound recordings and identified murmurs. Recordings were retrospectively saved and exported into wav files. MATLAB (The MathWorks Inc., USA) was used to write the software to analyse and display the signals as a waveform. Matlab® is high level software that allows digital signal processing and allows the visualisation of data e.g. creating waveforms from audio files e.g. heart sounds.[404] Matlab® can segment off audio files and generate segmented visualisations that allow the exploration of soundwave characteristics of specific cardiac abnormalities.[404]

4.3.1.2. To compare the waveforms of heart sounds from infants where murmurs were detected to waveforms of heart sounds from infants with no discernible murmur

Heart sounds from 8 infants (murmurs=2, normal=2, male=5, females=3) were selected from the database of recordings and exported and saved into wav files. (Table 4.1) The median age of the sound recordings with murmurs was 3 (0 to 8) months whilst the recordings with no discernible murmurs was 6 (3 to 9) months. A Consultant Paediatrician reviewed sound recordings and classified the recordings into one of four categories: no discernible murmur (n=2), grade 1 (n=1), grade 2 (n=2) or grade 3 and above murmur (n=3). Recordings were retrospectively saved and exported into wav files. MATLAB (The MathWorks Inc., USA) was used to write the software to analyse and display the signals as a waveform.

Table 4. 1: Summary data from the two groups of infants

Number of Infants n	6 (1 x Grade 1, 2 x Grade 2 and 3 x Grade ≥ 3)	2
Median (range) age months	3 (0 to 8)	6 (3 and 9)
Gender	5M 1F	2F

M= Male, F= Female

4.3.1.3. To investigate the ability of clinicians to retrospectively identify heart sounds in both local general and remote specialist hospitals

Heart sounds from 12 paediatric patients (murmurs=8, normal=4, male=6, females=2) were selected from the database of recordings and exported and saved into wav files. (Table 4.2) The median age of the sound recordings with murmurs was 70 (5 to 168) months whilst the recordings with no discernible murmurs was 37 (5 to 77) months. A Consultant Paediatrician reviewed sound recordings and classified the recordings into one of three categories: no discernible murmur (n=4), grade 2 (n=1) or grade 3 and above murmur (n=7).Recordings were saved and exported as wav files. MATLAB (The MathWorks Inc., USA) was used to time segment and amplify recordings.

The recordings were played through an external Bluetooth speaker and assessed by a total panel (n=38) consisting of 11 Consultants, 4 Senior House Officers or Registrars and 23 Foundation Year 1 clinicians. All assessments were conducted in non-clinical areas at CUH and at Royal Brompton Hospital. To test the auditability of the system by the clinicians, examples of one normal recording and a grade 2 murmur, at normal volume and after amplification were played. The panel was informed of the grade and timing of the sample murmurs and how to use a printed form provided (Appendix 5) to record their assessments. The panel then recorded their assessment of the remaining recordings (8 with murmurs and 4 with no discernible murmurs) on the printed form. The assessment form also questioned clinicians on the effectiveness, remote diagnostic abilities, and limitations of the system. The sensitivity, specificity, positive predictive and negative predicted value was calculated as per methodology from similar studies.[401] Sensitivity is the ability of a system to correctly identify those with murmurs (true positive

rate), whereas specificity is the ability of the system to correctly identify those without the murmurs (true negative rate).[405] The positive predictive value (PPV) is a "true positive" is the event that the system makes a positive prediction (murmur identified), and the patient has a positive result from an echocardiogram whereas the negative predictive value (NPV) is a "true negative" is the event that the system makes a negative prediction (no murmur), and the subject has a negative result from the echocardiogram.[406] The MHRA requires the following minimum performance from a system in order to approve its use: Sensitivity ≥80%, Specificity ≥ 99.5%.[407]

Table 4. 2: Summary data from the two groups of paediatric patients

Recordings	Murmur	No Murmur
Gender	3F/5M	3F/1M
Median (range) age months	70 (5 to 168)	37 (5 to 77)
Grade	1 x Grade 2 7 x ≥Grade 3	
Timing	Systolic (n=7) Systolic and Diastolic (n=1)	

M= Male, F= Female

4.3.1.4. To evaluate the usability of an electronic stethoscope and associated software amongst clinicians with different levels of experience

Clinicians were shown how to acquire heart sound recordings using a Littmann Model 3200 Electronic Stethoscope (3M, USA) and to transfer the recordings to the Littmann StethAssist Heart and Lung Sound Visualization Software (3M, USA). The total panel (n=38) of clinicians that acquired recordings and transferred them to the software consisted of 11 Consultants, 4 Senior House Officers or Registrars and 23 Foundation Year 1. The clinicians were asked to assess the usability of the stethoscope and software using a printed form (Appendix 6) consisting of 2 equipment specific questions, 10 general SUS questions (See Chapter 2) and a question on preferences, advantages, and limitations.

4.4 Results

4.4.1. Acquisition and compilation of a database of heart sounds from paediatric patients using an electronic stethoscope

Seventy-two participants (n=72) with suspected murmurs and forty (n=40) participants with no discernible murmurs were recruited into the study and their heart sounds were captured. All audio samples used were verified by echocardiogram and by the Consultant Paediatrician. Clinician examination and echocardiogram reports confirmed that participants had systolic murmurs (n=49), diastolic murmurs (n=6), continuous murmurs (n=4) and some participants (n=13) were excluded as their past medical history or current treatments change sound characteristics of their heart recordings.

4.4.1.1. Analysis of heart sounds from paediatric patients

Recordings from the database were selected and analysed from 12 children. The median age range of the six children with murmurs was 28 (3 to 161 months) and for the group without murmurs was 50 (19 to 125) months (Table 4.3).

Table 4. 3: The demographic data of paediatric patients

	Systolic Murmurs Grade 3 or 4	**No Murmurs**
Number of Children	6	6
Median Age Range (months)	28 (3 to 161)	50 (19 to 125)
Gender	3F/3M	1F/5M
Median weight range (Kg)	13 (4 to 40)	18 (12 to 26)

M= Male, F= Female

For the recordings without murmurs the waveform between heart sounds appeared regular and smooth whereas in the recordings with murmurs the waveforms between heart sounds had varying frequency with some higher frequency components (Figure 4.9).

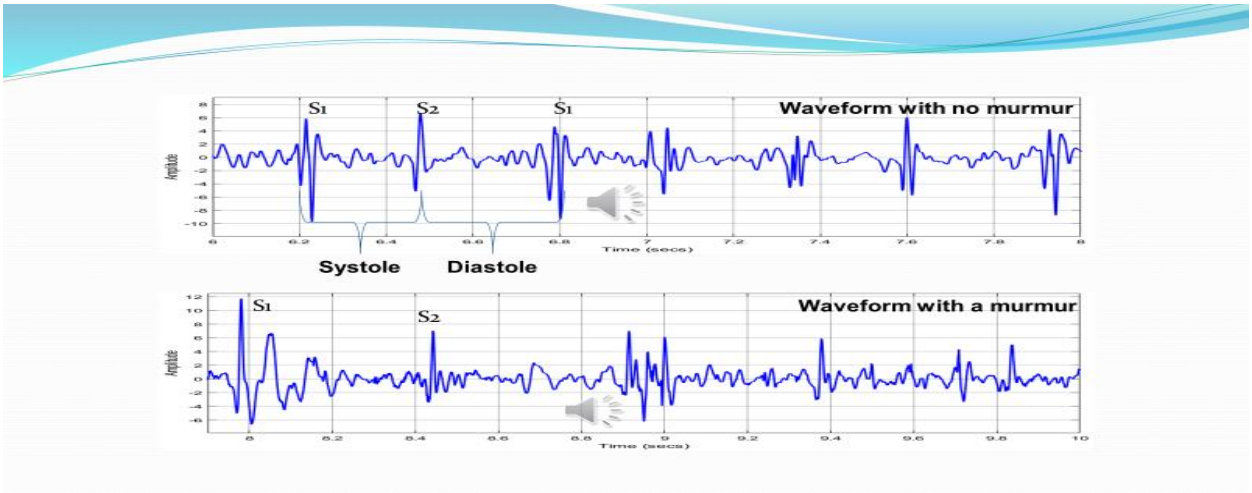

Figure 4. 9: Waveform recordings of a murmur and no discernible murmur

An example of a second section of a recording from both infants (<10 months) recordings without murmurs selected from the database revealed that the waveform between heart sounds appeared regular and smooth (Figure 4.10) .

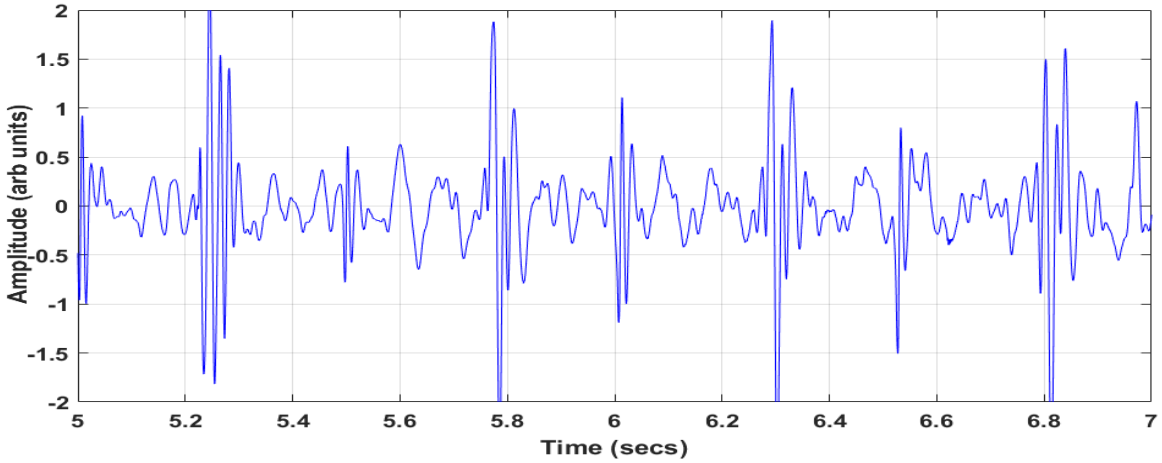

Figure 4. 10: Example of a 2 second section of recording with no murmur

In all 3 infants with grade 3 and above murmurs, there were clear high frequency components particularly following the first heart sound; the high frequency components could be visualised as spikes in the signal (Figure 4.11). The red arrows point to periods with high frequency components after the first heart sound. A similar pattern was seen in the grade two murmurs although the spikes were less apparent. In the grade 1

murmur the high frequency components seen in grade 3 and above murmurs were not present.

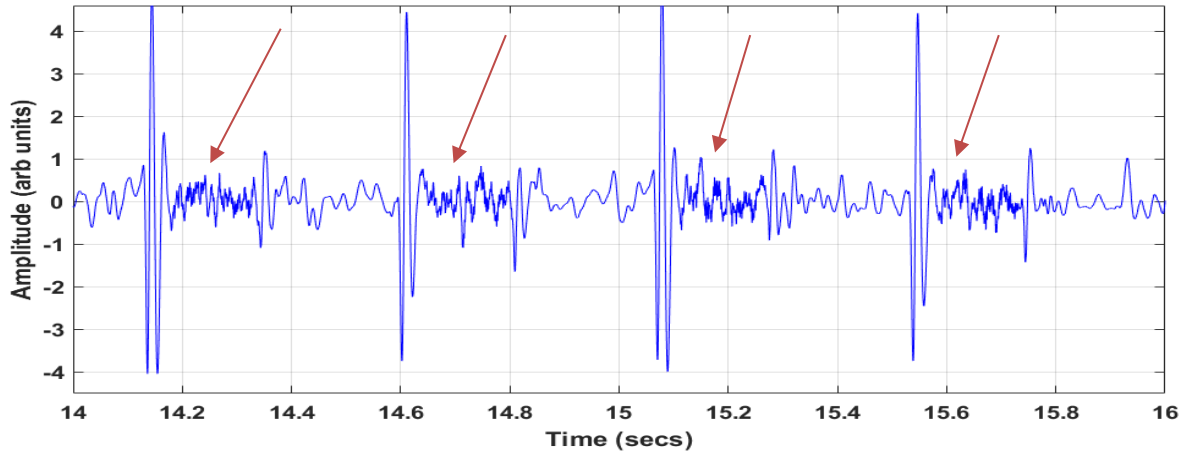

Figure 4. 11: Example of a 2 second section of a recording with a grade ≥ 3 murmur

4.4.1.2. Clinician retrospective assessment of heart sounds from both a local general and remote specialist hospital

Grade 3 and above murmurs were correctly identified with a minimum of 92% for all three groups of clinicians. For the grade 3 systolic-diastolic combination murmur, all but one clinician detected that there is a murmur but only 13 clinicians recognised the correct type of the murmur. Eight clinicians detected the grade 2 murmur. Therefore, the method success did not extend to the identification of the grade 3 systolic-diastolic combination murmur and a grade 2 systolic murmur. However, only one murmur of each type was tested. Furthermore, in some instances, the method tested resulted in the false identification of a murmur in recordings where murmurs were absent. The sensitivity of the system is equal to 77% whilst the specificity of the system is equal to 69%. The PPV is equal to 83% whilst the NPV is equal to 60%. A female consultant reported that it was easier to hear the systolic murmurs whereas a male Consultant of similar age reported that it was easier to hear the diastolic murmurs. See Table 4.4 below.

Table 4. 4: Percentage success of recordings correctly identified

Type of Recording	Correctly Identified		
	Consultants	SHOs and Registrars	Foundation Year 1
	(n=11)	(n=4)	(n=23)
Grade 3 and above murmur (n=6) n (%)	64/66 (97)	23/24 (96)	127/138 (92)
Grade 3 Systolic-Diastolic murmur (n=1) n (%)	3/11 (27)	0/4 (0)	10/23 (43)
Grade 2 murmur (n=1) n (%)	3/11 (27)	0/4 (0)	5/23 (22)
Absence of a murmur (n=4) n (%)	31/44 (71)	10/16 (63)	64/92 (70)

Most Consultants (n=7, 64%) reported that they were able to distinguish (effectiveness) between a normal and abnormal heart sound when listening to the audio samples. However, only a few of the Foundation Year 1 clinicians (n=5, 22%) reported being able to achieve this. All the registrars and SHOs (n=4, 100%) reported that it was possible to distinguish between a normal and abnormal heart sound when listening to the audio samples. Unfortunately, most Consultants (n=4, 46%), SHO and Registrars (n=2, 50%) and Foundation Year 1 (n=16, 70%) clinicians reported that they would not be comfortable to confirm a diagnosis remotely (remote diagnostic ability) using the system. Likewise, most Consultants (n=7, 64%), SHO and Registrars (n=2, 50%) and Foundation Year 1 (n=19, 83%) clinicians reported that they identified limitations with the system (Table 4.5).

Table 4. 5: Effectiveness, remote diagnostic abilities, and limitations of the system

	Effectiveness			Remote diagnostic ability			Limitations		
	Yes	No	Possibly	Yes	No	Possibly	Yes	No	Possibly
Consultant (n=11)	7 (64%)	0	4 (36%)	2 (18%)	5 (46%)	4 (36%)	7 (64%)	0	4 (36%)
SHO and Registrars (n=4)	0	0	4 (100%)	0	2 (50%)	2 (50%)	2 (50%)	0	2 (50%)
Foundation Year 1 (n=23)	5 (22%)	4 (17%)	14 (61%)	3 (13%)	16 (70%)	4 (17%)	19 (83%)	0	4 (17%)
Total (n=38)	12 (32%)	4 (11%)	22 (58%)	5 (13%)	23 (61%)	10 (26%)	28 (74%)	0	10 (26%)

Only 3 (8%) clinicians commented that they would be comfortable to use the system to detect murmurs (table 4.6). Most of the Consultants (n=10, 91%) commented that the audio quality was too poor to confirm a diagnosis. Clinicians reported that the

amplification of the audio files resulted in sound interference that increased the difficulty of confirming a diagnosis when listening to audio files. Most of the Foundation Year 1 clinicians (n=16, 70%) reported that the system lacked patient contact and limited a full physical clinical evaluation e.g. assessing pallor and thrills. Interestingly, all of the SHOs and Registrars (n=4, 100%) and most of the Foundation Year 1 clinicians (n=15, 65%) reported that their lack of experience was a significant limitation to using the system to remotely diagnose heart sounds and that the variation of experience of clinicians would affect diagnostic accuracy (table 4.6).

Table 4. 6: Thematic frequency analysis of comments

	Murmur Detection	**Poor Audio Quality**	**Lack of Patient Contact**	**Lack of Experience**
Consultant (n=11) n (%)	2 (18%)	10 (91%)	3 (27%)	2 (18%)
SHO and Registrars (n=4) n (%)	0	3 (75%)	1 (25%)	4 (100%)
Foundation Year 1 (n=23) n (%)	1 (4%)	7 (30%)	16 (70%)	15 (65%)
Total (n=38) n (%)	3 (8%)	20 (53%)	20 (53%)	21 (55%)

Based on the feedback received from clinicians above, an experienced Consultant Paediatric Cardiologist agreed to evaluate the same audio files directly via the original 3M® Stethoscope system. This study resulted in an improvement in the identification (n=1), timing (n=3) and grade (n=1) of murmur/s and heart sounds with an absence of murmurs (n=1) as highlighted in Table 4.7. The Consultant Paediatrician reported that the amplification heard through the speaker system increased the difficulty of accurately identifying grade and timing of a murmur whereas the 3M® Stethoscope allowed the clinician to choose the most desirable volume level to facilitate the most accurate diagnosis.

Table 4. 7: Telehealth Auscultation Method Comparison

Identification of a Murmur or Absence			Identification of Timing			Identification of Grade		
Type	**Speaker**	**Stethoscope (3M)**	**Timing**	**Speaker**	**Stethoscope (3M)**	**Grade**	**Speaker**	**Stethoscope (3M)**
Murmur	✓	✓	Systolic	✓	✓	4	✓	✓
Murmur	✓	✓	Systolic	✓	✓	4	✓	✓
Murmur	×	✓	Systolic and Diastolic	×	✓	3	✓	✓
Normal	×	✓	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Normal	×	×	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Murmur	✓	✓	Systolic	×	✓	3	×	✓
Murmur	✓	✓	Systolic	✓	✓	3	✓	✓
Murmur	✓	✓	Systolic	✓	✓	3	✓	✓
Normal	✓	✓	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Murmur	✓	✓	Systolic	✓	✓	3	✓	✓
Normal	✓	✓	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Murmur	✓	✓	Systolic	✓	✓	1	×	×
Murmur	✓	✓	Systolic and Diastolic	×	✓	3	✓	✓

4.4.2. Usability of an electronic stethoscope and associated software amongst clinicians with different levels of experience

All clinicians were able to acquire heart sounds using an electronic stethoscope. Most clinicians (n=32, 84%) reported that it was easy to connect the electronic stethoscope via Bluetooth to the laptop and to use the software with 5 (13.5%) remaining neutral and 1 clinician indicating that it was not easy to connect the electronic stethoscope via Bluetooth to the laptop. The mean SUS score for all clinicians was 67.5 and a range from 0 to 100.

The SUS scores (see Chapter 2) reported by the Consultants (75) fell in the 5th quartile with a good accurate adjective rating. The SUS scores reported by the SHO and Registrars (70) fell in the 4th quartile of the acceptable range with marginal adjective rating. The Foundation Year 1 clinicians reported SUS scores (Mean=57.5) in the 2nd quartile of a marginal acceptable range with an okay adjective system rating.

Table 4.8: Usability SUS Scores

	Median SUS Score
Consultants (n=11)	75.0
SHOs and Registrars (n=4)	70.0
Foundation Year 1 (n=23)	57.5
Mean SUS Score	67.5

Only 3 Consultants (27%), 2 SHOs and Registrars (50%) and 10 Foundation Year 1 (44%) clinicians reported that they would prefer to use the electronic stethoscope and associated software (Table 4.9). However, 8 Consultants (73%), all the SHOs and Registrars (100%) and 19 Foundation Year 1 (83%) clinicians reported that there were advantages to using the electronic stethoscope and associated software (Table 4.9). Clinicians reported that advantages included that the electronic system was cost-effective (n=2, 5%), allowed to decrease the speed of the heart sound (n=2, 5%), could be used as an educational tool (n=7, 18%), allowed the increased in volume of heart sounds(n=6, 16%), reduced interference noise (n=9, 24%) and allowed retrospective review of heart sounds (n=21, 55%) (Table 4.10). With this in mind, 4 Consultants (36%), 1 SHO or Registrar and 10 Foundation Year 1 (44%) reported that there were limitations to using the electronic stethoscope and associated software (Table 4.9).

Clinicians reported that limitations to using the electronic stethoscope and associated software included loss of professionalism and/or self-confidence due to dependency on technology (n=1, 3%), additional time required for training and usage (n=2, 5%), lack of patient contact (n=6, 16%) and additional costs associated with training and equipment (n=16, 42%) (Table 4.11).

Table 4. 9: Preferences, Advantages and Limitations of the electronic stethoscope

Responses	Preferences			Advantages			Limitations		
	Yes	No	Possibly	Yes	No	Possibly	Yes	No	Possibly
Consultant (n=11) n (%)	3 (27%)	2 (18%)	6 (55%)	8 (73%)	1 (9%)	2 (18%)	4 (36%)	5 (46%)	3 (27%)
SHO and Registrars (n=4) n (%)	2 (50%)	2 (50%)	0	4 (100%)	0	0	1 (25%)	2 (50%)	1 (25%)
Foundation Year 1 (n=23)	10 (44%)	8 (35%)	5 (22%)	19 (83%)	1 (4%)	3 (13%)	10 (44%)	9 (39%)	4 (17%)
Total (n=38)	15 (40%)	12 (32%)	11 (29%)	31 (82%)	2 (5%)	5 (13%)	15 (40%)	16 (42%)	8 (21%)

	Cost-Effective	Decrease Speed	Educational Tool	Increased Volume	Reduced Noise	Retrospective Review
Consultants (n=11)	1 (9%)	0	2 (18%)	1 (9%)	3 (27%)	4 (36%)
Senior House Officer and Registrars (n=4)	0	1 (25%)	2 (50%)	0	1 (25%)	2 (50%)
Foundation Year 1 (n=23)	1 (4%)	1 (4%)	3 (13%)	5 (22%)	5 (22%)	15 (65%)
Total (n=38)	2 (5%)	2 (5%)	7 (18%)	6 (16%)	9 (24%)	21 (55%)

Table 4. 10: Thematic frequency analysis of limitations of the electronic stethoscope

	Loss of Professionalism / Self-Confidence	Time	Lack of Patient Contact	Additional Costs
Consultants (n=11) n (%)	0	0	4 (36%)	5 (46%)
Senior House Officers and Registrars (n=4) n (%)	0	0	0	1 (25%)
Foundation Year 1 (n=23) n (%)	1 (4%)	2 (9%)	2 (9%)	10 (44%)
Total (n=38) n (%)	1 (3%)	2 (5%)	6 (16%)	16 (42%)

4.5. Discussion, limitations, and future

Mobile technology has great potential to support clinicians in early detection of congenital abnormalities through offering new diagnostic techniques, enhancing clinician auscultation skills, allowing respective and remote review of heart sounds and adapting systems for usability within current practice.[378–380,382] It has been found that it is more cost-effective for paediatricians to refer patients to a paediatric cardiologist than to request an echocardiogram, however, increased training and development of auscultation skills during residency can result in an increased cardiac diagnostic accuracy of innocent or functional murmurs among clinicians and may avoid the cost of referral. [397,408] In fact, training has been found to lead to improved performance in the detection of cardia murmurs.[409]

The recruitment rate of paediatric patients into studies has been reported as challenging[410] however this study had a high recruitment rate (n=72, 82.8%) as the intervention was perceived as non-invasive, the time required for recording heart sounds per patient was minimal (less than 5 mins) and was conducted whilst patients were waiting to see the Consultant and no further participation was required by both paediatric patients or their parents/legal guardians once the heart sound was recorded.[411,412] The researcher is a healthcare professional with over fifteen years' of professional experience as a pharmacist and had prior experience of working at CUH which aided the ease of recruitment of both patients with a suspected congenital cardiac condition (n=72) and patients with no known cardiac condition (n=40).

Previous studies have reported that between 50% to 70% of paediatric patients referred to a paediatric cardiologist did not need any intervention however, this study identified that 59 patients (82%) of the 72 patients recruited were suitable for the study.[345,399,400] This high rate of paediatric patients that had murmurs [systolic murmurs (n=49), diastolic murmurs (n=6), continuous murmurs (n=4)] was potentially due to the Paediatrician having special interest in paediatric cardiology and therefore pre-screening and selecting patients for admission into the Paediatric Cardiologist clinic in order to optimise the appointment time. This allowed the visiting Paediatric Cardiologist to assess and treat the paediatric patients with the most severe congenital cardiac conditions.

The importance of cardiac auscultation was identified by Robert Hooke [363] over 300 years ago and in 1963 Segall [362] recommended that we must record heart sounds but they were both limited by the quality of stethoscopes and data recording equipment during their eras.[384–392] A more recent study (2005) has been able to successfully record and segment heart sounds and use an automated algorithm to identify the S1 and S2 sounds.[380] Building on this, 3M™ released the Littmann Model 3200 Electronic Stethoscope (3M™, USA), Littmann StethAssist Heart and Lung Sound Visualization Software (3M™, USA) and the only FDA-approved diagnostic software (Zargis Cardioscan™) to classify suspected systolic and diastolic heart murmurs.[413] Unfortunately, 3M™ has withdrawn their Zargis Cardioscan™ software of the market.

Developing murmur detection software is a challenging process and the sensitivity and specificity of the software depends on the quality of the audio database, the accuracy of the algorithm and the technical skill of the user. The researcher trained with the Paediatrician with a special interest in paediatric cardiology, an experienced Consultant Paediatrician, and an experienced Paediatric Cardiologist in order to improve both auscultation skills and technical usage of the Littmann Model 3200 Electronic Stethoscope (3M™, USA). This enhanced the quality of the heart sound recording with minimal artefact and noise disturbance. This resulted in the ability to produce high quality waveforms using MATLAB (The MathWorks Inc., USA) that showed that paediatric patients with a murmur have varying frequency and higher frequency components between heart sounds whereas paediatric patients with no known cardiac condition had regular and smooth waveforms between heart sounds. Whilst a similar result was seen when evaluating the waveforms of infants (<10 months), the higher-grade murmurs e.g. Grade 3 presented with easily identifiable high frequency spikes following the first heart sound but the was less apparent in Grade 2 murmurs and not apparent in Grade 1 murmurs. This method of spectral analysis was successful in identifying Grade 3 and above congenital systolic murmurs.

The retrospective assessment of heart sounds in both local and a remote hospital is a valuable tool if system has a high specificity and sensitivity.[401] In the UK, the MHRA would require a minimum sensitivity ≥80% and specificity ≥ 99.5%.[407] and therefore, sensitivity (77%), specificity (69%), PPV (83%) and NPV (60%) of the speaker system was too low to be considered to be used in standard practice. It is therefore not surprising that most of the Foundation Year 1 clinicians (n=18, 78%) reported possibly

not being able to use the system in order to distinguish between a normal and abnormal heart sound and that they (n=16, 70%) would not be comfortable to confirm a diagnosis remotely due to its limitations (n=19, 83%). All the SHO and Registrars (n=4, 100%) and most of the Foundation Year 1 clinicians (n=15, 65%) reported that their lack of experience was a limitation of the speaker system. Mesquita CT et al.[380] used the electronic stethoscope (Littmann® Model 3200, 3M™) and its original associated software to successfully develop cardiac auscultation skills of undergraduate medical students with greater improvement observed in those using the electronic stethoscope (59.1%) compared to those students that used a traditional stethoscope (29.5%). Thus, the recordings acquired in this study could be used to improve the skills of SHOs and Registrars and Foundation Year 1 clinicians.[380]

The speaker system increased the amplitude of the Grade 2, Grade 3 systolic-diastolic murmur and Grade 3 heart sounds resulting in most Consultants (n=10, 91%) and SHOs and Registrars (n=3, 75%) reporting that the sound files were poor quality due to excessive noise artefact. It is interesting that two Consultants of similar age and different genders reported the systolic high frequency murmurs were easier to hear (female) whereas the male counterpart reported that the lower frequency diastolic murmurs were easier to hear. This feedback is supported by previous studies that have reported that ageing females retain their ability to hear higher frequency sounds longer than ageing males whilst ageing males retain their ability to hear lower frequency sounds longer than ageing females.[386,394–396] The diastolic component of a systolic-diastolic murmur is lower frequency and was missed by all the SHOs and Registrars and most Consultants (n=8, 73%) and Foundation Year 1(n=13, 57%) clinicians. This may have occurred as the ear may not identify low frequency sounds (diastolic murmur) that immediately follow high frequency sounds (systolic murmur).[388]

The improvement in diagnostic accuracy from the speaker system to the 3M™ Stethoscope system with associated software is clinically significant as it allowed the same experienced Paediatric Cardiologist Consultant to correctly remotely assess both a sound recording of a murmur and a sound recording with an absence of a murmur that was previously incorrectly assessed. Further studies need to be conducted to evaluate if this benefit is seen in other categories of clinicians.

However, the results above could be linked to the feedback received from most clinicians (n=32, 84%) that it was easy to use the 3M™ electronic stethoscope and associated software. The Consultants (Mean SUS=75) and SHOs and Registrars (Mean SUS=70) rated the usability of the 3M™ Stethoscope and associated software as good and acceptable respectively whilst the Foundation Year 1 (Mean SUS=57.5) clinicians rated it as okay. It is therefore not surprising that all of the SHOs and Registrars and most of the Consultants (n=8, 73%) and Foundation Year 1 (n=19, 83%) clinicians reported that there were advantages to using the 3M™ electronic stethoscope and associated software including the ability to retrospectively review heart sounds (n=21, 55%) and reduce the noise with the use of the electronic filters (n=9, 24%). Clinicians (n=16, 42%) were concerned about the additional costs associated with using the 3M™ Stethoscope and associated software e.g. equipment, laptops, and training.

4.5.1. Conclusions

The Physicians Ear mobile technology feasibility studies have successfully recorded cardiac sounds and created waveforms that could be used for diagnostic purposes. The retrospective and remote review of audio files is advantageous to both patients and clinicians and saves resources but cannot be the main source for diagnosis but to augment it, however, it can have value as an educational resource or for enabling remote diagnostic value especially in those living in rural areas or those with no access to specialised healthcare. The transmission of audio files from local centre to a specialist centre or from less specialist HCP to specialist may speed diagnosis and access to care. Further evaluation of the 3M™ electronic stethoscope and its associated software is required to test the feasibility of remote diagnosis of congenital cardiac murmurs and its ability to develop of cardiac auscultation skills of clinicians. Systems need to be tested for both robustness (sensitivity and specificity) and usability within current clinical practice.

4.6. Author Contributions

Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND	✓
Drafting the work or revising it critically for important intellectual content; AND	✓
Final approval of the version to be published; AND	In progress
Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.	✓

Chapter 5: Conclusions and Recommendations

5.1. Research Review

The NHS funding gap (£30 billion) was identified in 2014 as a critical limitation factor in being able to sustain the NHS. The major driver of cost in the NHS is long-term conditions e.g., COPD, Diabetes, CVD that account for up to 70% of its total healthcare budget. Digital solutions, that is, technology enabled care e.g., telehealth, telecare, and telemedicine were identified as having the potential to reduce the cost burden, but implementation was slow. In 2019, the COVID-19 virus stimulated the rapid implementation of technology enabled care to minimise viral transmission and maintain healthcare services in the NHS. However, technology adoption is influenced by perceived ease of use and perceived usefulness factors that impacts on HCPs' attitudes, beliefs, perceptions, and intentions. Successful adoption of technology has the potential to improve patient healthcare and social outcomes.

This practice-based research evaluated the feasibility of using digital solutions in different healthcare settings within Croydon NHS Trust to support the provision of healthcare by:

- Evaluating the feasibility of using a digital monitoring system of care home residents with dementia and exploring multidisciplinary HCPs' awareness and experiences of TH and their perceptions of it pre and post implementation in the care home (Chapter 2).
- Evaluating a readmission risk score prediction model (OPTIMAL) with and without a post-discharge intervention and evaluating patients' satisfaction with the OPTIMAL post-discharge intervention and its effect on their discharge experience (Chapter 3).
- Evaluating the feasibility of using an electronic stethoscope by acquiring and compiling a database of heart sounds from paediatric patients. The evaluation involved the comparison of the waveforms of heart sounds from infants where murmurs were detected to waveforms of heart sounds from infants with no discernible murmur, the investigation of the ability of clinicians to retrospectively identify heart sounds in both local general and remote specialised hospitals settings and to evaluate the usability of an electronic stethoscope and associated software amongst clinicians with different levels of experience (Chapter 4).

5.2. Research Methodology

A mixed-method research approach was used throughout this research to achieve its aims and objectives.

To evaluate the feasibility of using a digital healthcare solution for early monitoring of residents with dementia in a care home, a mix of qualitative and quantitative research methods were used over three six-month phases [control phase (CP), active monitoring phase (AMP) and active monitoring with text alerts (AMTAP)]. To determine the impact of Tunstall myClinic® on residents' clinical outcomes, carers recorded vital signs and completed health assessment questions. In AMTAP, the early warning triage system generated text alerts when abnormal responses or vital signs were detected. Twenty-seven residents participated during the CP and AMP whilst only fourteen residents participated during AMTAP. The quantitative section of this study calculated the frequency effect of the telehealth solution on the GPV, AP, ED visits and IP events whilst the qualitative section of this study explored multidisciplinary HCPs' awareness and experiences of the telehealth system and reported on their perceptions pre and post implementation. The quantitative data was analysed statistically using the non-parametric Sign test to report on any statistically significant differences in outcomes between the 3 phases of the study and the interviews were analysed thematically using the TDF model to provide a robust theoretical basis for the analysis.

To evaluate a readmission risk score prediction model (OPTIMAL) with and without a post-discharge intervention and evaluate patients' satisfaction with the OPTIMAL post-discharge, patients (n=1475) were recruited and allocated to intervention (n=745) and control arms (n=730). Patient randomised to the intervention arm received a call from the DA within 2 to 10 days after discharge and were signposted to community services as needed. A randomly selected intervention (n=265) and control group (n=265) were selected from the recruited participants for evaluation via a survey administered by phone. Data acquired was analysed descriptively and inferentially to identify statistically significant differences between means of outcomes between the intervention and control arms (T-test) and association and correlation between variables (Chi-squared test and Pearson Correlation).

The third study evaluated the feasibility of using an electronic stethoscope, for the detection of congenital heart murmurs and its usability and associated software

amongst clinicians with different levels of experience. Paediatric patients (n=72) attending a Paediatric Cardiologist led outpatient clinic and forty (n=40) age-matched participants with no discernible murmurs consented to 30-second heart sound Consultant Paediatrician verified recordings at the 2nd right intercostal space, 2nd left intercostal space, 3rd left intercostal space, 4th left intercostal space and the 5th left intercostal space tending towards the sternal edge using a 3M™ Littmann® Electronic Stethoscope Model 3200 to create a heart sound database. MATLAB (The MathWorks Inc., USA) was used to create sound waveforms and the 3M™ Littmann Steth Assist Heart and Lung Sound Visualization Software® to record and playback heart sounds. A total of 38 HCPs were recruited to evaluate the recordings. The analysis involved the calculation of the specificity and sensitivity of the system. It also evaluated the feedback from the HCPs about the recordings and the software (usability, advantages, and limitations) through a survey.

5.3. Key Findings

The digital solution was offered to AL residents (n=27, age median=86.0 years) with moderate dementia. However, due to poor participant selection e.g., severe BPSD, only around half (n=14) of the residents were able to complete the AMTAP phase of the study. BPSD associated dementia in residents resulted in unnecessary text alerts and residents therefore missed the opportunity to benefit from the digital solution. Low completion rates were also impacted by the low acceptability of the intervention as it caused residents discomfort and distress and directly impacted on participants' non-compliance or persistence with the intervention.

The THS seemed to increase HCPs' awareness of residents' health status resulting in a statistically significant increase in GPV ($f=59$, $p=0.009$) and AP ($f=44$, $p<0.001$) from CP to AMP. This increase resulted in a decrease in ED ($f=28$, $p=0.454$), IP ($f=25$, $p=0.607$) and mean IP days (6 days) during AMP. Text alerts during AMTAP had the effect of increasing GPV (n=4, p=0.09) and AP (n=6, p=0.031) and accounted for nearly half 47.7% of GPV (n=31/65) and 90% of the AP (n=18/20). The decrease in ED and IP during AMTAP highlights TH potential to raise HCPs' awareness of residents' health resulting in earlier disease treatment thus preventing hospital admission and reducing length of hospital stay. This result was even more meaningful as the decrease occurred in preventable reasons for hospital admissions e.g., falls, urinary and respiratory tract infections. If the THS had a glucose monitoring sensor, it could have prevented the

strong correlation between hypoglycaemic admissions in residents that have a history diabetes (τb = 0.693, p<0.001) during AMP. There was only a strong positive statistically significant correlation (τb=0.68,p=0.012) between having arthritis/osteoarthritis and being admitted for a fall during CP as the increased HCPs' awareness during AMP due to TH might have been the cause for reduced admissions for falls. The texts alerts to RRT might have prompted the observed increase in medication prescribing during AMTAP due to risk avoidance clinical decision making. The significant movement of the medicines optimisation from hospital to AL during AMP (p<0.001) and AMTAP (p=0.016) and decrease in prescribing of high risk medicine and medication known to cause falls during AMP may have resulted in a decrease in admissions for falls during AMP [(n=27, RRR=93.8%, OR=0.0625 95% confidence interval 0.0077 to 0.5051, p=0.0093), (n=14, RRR= 80%, OR=1.2, 95% confidence interval 0.2962 to 4.8617, p=0.7984)]. This highlights the need for regular care home medication reviews by pharmacists. The THS increased vital sign monitoring from monthly to once weekly but was not enough to prevent avoidable hospital admissions. Vital sign monitoring should be done only as frequently as needed to prevent hospital admissions through early detection of signs of deterioration in health whilst balancing the impact of increased monitoring on residents with dementia.

The lack of management support was a regular theme and resulted in critical management incidents e.g., poor handover between mangers and no support for staff when the equipment failed. The TH training bonded those HCPs that attended and isolated those that did not attend e.g., GPs. RRNs facilitated training for AL HCPs after the initial training and therefore HCPs who received training and used the THS rated the THS as acceptable unlike those HCPs who felt isolated. Management needed to ensure adequate TH training for all HCPs to increase TH awareness and identify TH champions to promote and support behavioural change. This is even more relevant due to AL high staff turnover. HCPs questioned the value of a THS in care homes with nursing availability and indicated its value in non-nursing care homes. Nevertheless, they all recognised its impact on their job efficiency and effectiveness, by ensuring a quicker response to residents' changing health needs. Overall, despite various barriers to adoption and staff not knowing the impact of the THS on GPV, AP, ED, IP and duration of hospital admissions on AL residents, HCPs reported that they would like to continue using TH in a non-nursing home and other therapy areas e.g. COPD.

The OPTIMAL discharge intervention was not successful due to study design methodology. Patients (n=1475) with a lower risk score were recruited into the study and therefore the post discharge intervention was not effective in reducing 30-day readmissions when compared to the control group. The shortage of DAs resulted in a lower recruitment rate and participants receiving their discharge intervention later than needed to have a benefit to the patient. Mobile technology (92%) increased the ability to contact patients from landlines (32%) due to text messaging and voicemail features. Even though the evaluated sample had a statistically significantly higher mean age ($p=0.022$) and mean OPTIMAL readmission risk percentage score ($p=0.001$) than the study group, the dual layer of post discharge phone call offered by the pharmacist researchers and the DA nurses resulted in the evaluated intervention group having the lowest readmission rate in the study. The 30 day-readmission rate was statistically significantly lower in the evaluated sample compared to the whole sample ($p=0.008$) and the intervention evaluated group had a statistically significantly lower 30-day readmission rate than the control group ($p<0.001$). The OPTIMAL system was accurate in predicting the actual 30-day readmission rate (15.12%) for the control (15.95%) and intervention (16.6%) groups increasing its robustness. The OPTIMAL system offers a simple post-discharge intervention, and this may have not been effective to prevent 30-day readmission as more complex interventions are deemed more effective based on the literature. However, patients reported that they valued the post-discharge intervention service as it allowed them to resolve any unmet healthcare needs e.g., GP appointments. It is evident though that the intervention despite its simplicity may have an impact on those at high risk of readmission.

Lastly for the Physicians Ear, this study had a high recruitment rate (n=72, 82.8%) as it was conducted in a Consultant Paediatric Cardiologist led paediatric murmur clinic. The database generated from heart sound records once analysed revealed that paediatric patients with a murmur has varying frequency and higher frequency components between heart sounds whereas paediatric patients with no known cardiac condition had regular and smooth waveforms between heart sounds. When playing the heart sounds through a Bluetooth speaker, HCPs reported an unacceptable sensitivity (77%), specificity (69%), PPV (83%) and NPV (60%) of the speaker system. These parameters were too low for the software to be used in standard practice but may prove useful as a

training tool for FY1 clinicians. Clinicians were able to use the electronic stethoscope to acquire a recording but did not feel that it is a useful system for them to diagnose murmurs. However, the results indicate that the 3M™ Stethoscope and associated software has potential to support HCPs by being able to send heart sound recordings from a general local hospital to a remote specialist hospital as part of a clinical referral.

A key finding from the studies in this thesis, is that although their main aim was to assess the feasibility of a digital solution in real practice, the design adopted a pilot or RCT design of an implemented intervention in day-to-day practice, apart from the study presented in Chapter 4, without a preceding feasibility study. Feasibility studies need to be conducted pre a digital solution implementation. A feasibility study asks whether something can be done, should we proceed with it, and if so, how? They are used to estimate important parameters that are needed to design the main study e.g. inclusion criteria, the frequency of monitoring and the study duration. This would also improve the success of studies but also increase technology adoption. In chapter 4, for example, the feasibility studies highlighted both the value contribution of using digital healthcare to support remote diagnosis and education whilst highlighting the chasms in technology adoption e.g. the proposed Bluetooth speaker system. A similar design for the THS in care home would have highlighted issues with using thermometer probe for temperature and the challenges with using a weighing scale. Feasibility studies can also highlight additional parameters that are needed to be evaluated e.g., blood glucose. Most importantly, feasibility studies will inform both participants selection and study design methodology. Participants selection directly impacts on study outcomes e.g. both the clinical stability and ability of residents to participate in the dementia study was underestimated decreasing participant completion rates. Another example of the impact of participant selection on study outcomes was seen in the OPTIMAL study where patients with a lower risk score were recruited into the study reducing the ability of the digital healthcare intervention to impact on patient outcomes e.g., reduction of 30-day readmissions. Considering age was reported as a significant factor associated with frequent admissions (>2 in 12 months), recruiting older participants into the evaluation, would have increased the risk of participants and given participants the opportunity to fully benefit from the OPTIMAL intervention.[152] Interestingly, the largest global trial platform for oral anti-virals for outpatients PANORAMIC, has faced similar challenges of recruiting participants of a lower risk profile reducing the reported effectiveness of

treatments and challenging the development of NICE Guidance: Therapeutics for people with COVID-19.[414,415]

Regardless, it is evident that implementation of digital healthcare solutions whilst challenging has potential to offer both HCPs and patients improved outcomes. Careful consideration needs to be given to understanding the potential factors that will impact on technology adoption both pre and post implementation. Pragmatic application of the TDF[138] and TRAM[133] are useful tools to guide on identifying behaviour change techniques and designing intervention strategies to overcome challenges in implementation and increase successful technology adoption. Reflecting on the three studies, the researcher recommends that early identification of challenges perceived by users could aid development of customised training materials to support end users of digital healthcare and overcome misconceptions and biases. Adopting such a strategy will potentially increase integration of digital healthcare within the users environment with potential improvement in outcomes for patients.

5.4. Limitations

This feasibility analysis has several limitations. The small sample sizes in high-risk populations e.g., residents with dementia and paediatric patients are a known challenge. The risk of bias arising from the absence of a perfectly matched control group, when evaluating digital solution's impact on clinical outcomes over a limited time needs to be noted. The COVID-19 pandemic had the impact of a double edge sword: on the one hand it accelerated the implementation of digital solution in the NHS however as the research is a HCP, this write up was paused thus some of the literature maybe outdated, however, a fresh literature search was conducted, and updated studies were included as much as feasible.

5.5. Recommendations

To ensure the successful adoption of digital solutions to optimise the care of patients with LTCs, there needs to be a harmonious fit between the technology, environment and the patient.

The technology needs to be suitable to its purpose. Feasibility testing of technology within real life healthcare environment is essential. Technology must undergo rigorous

alpha and beta testing before it is released and be adaptable to the environment and modifiable to future versions of itself. Through consulting with HCPs, patients and healthcare funders, the design of the technology needs to be adaptable to various environments and care pathways. The use of the MATLAB to manipulate the heart sounds and the playback through the Bluetooth speaker resulted in a poorer quality of playback, HCPs rejecting the system as it did not meet the minimum SUS, sensitivity, specificity, PPV and NPV and the system being rejected. Close strategic alignment between the technology and environment will increase the perceived ease of use and perceived usefulness of the technology and improve HCPs beliefs, perceptions and intentions of the technology resulting in technology adoption.

The environment is constantly changing and this need to be assessed before implementing digital solutions in the NHS. The COVID-19 pandemic has caused a large impactful change in the environment and both patients and HCPs needs have changed. It is important for us to understand the impact of the pandemic as well as the post-pandemic phase as we enter a hybrid healthcare environment that requires both virtual and face to face interactions. The current demand for concise on demand relevant treatment protocols has increased due to limited resources in the NHS. The technology needs to be able to support this need. The AHSNs across England must be consulted from the design phase of the technology. A detailed understanding of the environment will result in ensuring that technology is modified in its design phase and can be seamlessly integrated into the standard operational practices and care pathways. This will allow a consultative process to occur before technology is implemented and eliminate feelings of shock and being forced to change working practices. The RRT team facilitated the adoption of digital solutions in AL and this had a synergistic effect on the AL nurses who volunteered the role of digital solutions ‘champions’ teaching the AL carers how to use the technology. This had a mutually beneficial impact on the relationship between the carers (as they had learned to do something new) and the AL nurses who felt they were increasing their professional role and responsibility.

Lastly and perhaps most importantly, is the patient. The poor recruitment of patients has been a consistent theme in both Chapters 2 and 3. Patients must be carefully selected without bias and poor patient selection has resulted in a participant drop-off during the trial (Chapter 2) and study intervention failure (Chapter 3). The NIHR patient recruitment centre can be used to identify patients who fall within the range of the demographic (e.g.

age) and co-morbidity (e.g. diabetes) profiles that could potentially best benefit from the digital solution being trialled.

The strategic fit of digital solutions with the technology, environment and the patient will ensure the successful adoption of digital solutions and aligns healthcare outcomes with the goals of the “NHS Long-Term Plan”.

5.6. Future Work

The recommended future work for this research is as follows:

- An evaluation of the feasibility of using digital solutions in non-nursing care homes and exploring HCPs’ pre and post implementation perceptions.
- An evaluation of the feasibility of using an enhanced OPTIMAL post-discharge intervention that offers multiple interventions to reduce 30-day readmissions with recruitment that is supported by a patient recruitment centre by selecting those patients at higher risk of readmission and exploring HCPs’ perceptions pre and post implementation.
- An evaluation of the feasibility of using an electronic stethoscope to support the remote identification of congenital murmurs in developing countries e.g., South Africa.

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Appendices

Appendix 1: Tunstall myClinic® Pre-Study Questionnaire for Carers

Section A: Experience to date

1. **What is your understanding of TH?**
   Follow-up: Will it replace GP, nurses...?

2. **What is your experience to date with regards to TH?**
   Follow-up: patient acceptability, ability to recruit, etc.

3. **Can you tell us the story of how you got involved in TH?**

4. **What kind of training did you receive on the system? How did you find it?**
   Follow-up: How difficult was it, how well was it delivered, how to improve it.

5. **From the technological part of the service, what do you think of the current system?**
   Follow-up: Peripheral devices and ICP triage manager.

6. **What challenges for the implementation of TH, if any, have you identified or experienced?**
   Follow-up: How much time does it take/day or/week?

7. **Do you think that your patients will consent to using TH at Albany?**
   Follow-up: the absence of direct contact, self-managing.

8. **How does your involvement in this project fit with your day to day work?**
9. **What do you think the impact of TH will be on your patients at Albany?**
10. **What do you think the impact of TH will be on you?**
11. **What do you think the impact of TH will be on Albany health service?**

Section B: Future of TH Service

12. **Do you think the implementation of TH should be a priority to a care home? Why?**

13. **Is the implementation of TH a priority to you? Why?**
    Follow-up: On a scale of 1-10 with 10 being extremely important

14. **What can YOU do to ensure the success of the implementation of TH?**

15. **What would you like the CCG to do differently to support the success of this service?**

16. **How confident are you that this service will succeed and continue?**
    Follow-up: On a scale of 1-10 with 10 being extremely confident

17. **Would YOU do anything different? And why would you make this change?**

18. **What other type of patients/conditions, in your opinion, are most suited for this service?**
    Follow-up: age, ethnicity, have carers, partners, etc.

Appendix 2: Tunstall myClinic® Pre-Study Questionnaire for Healthcare Professionals

Section A: Background

1. Can you please describe the service that you offer the patients at AL?
2. Please describe the size/demographics of the population that you provide a service to?
3. What is your understanding of TH?
4. What is your experience to date with regards to TH?

Section B: Impact of TH

5. What do you think the impact of TH will be on your patients at Albany? Why?
6. How do you feel about the implementation of TH at Albany?
7. What type of patients/conditions, in your opinion, are most suited for this service?
8. Do you think the implementation of TH should be a priority to a care home e.g. AL? Why?
9. Do you feel that the information from the TH will affect your clinical decisions on patient management?
10. What do you think will be the impact of TH on you and your patient care? Why?
11. Do you think that the information from the THS would affect the rate at which clinical decisions are made regarding patient management?
12. If your patients are transferred to another care home, do you think that the information from TH will influence their care received?

Section C: Challenges

13. What do you think some of the challenges for the implementation of TH at AL, if any, could be identified or experienced?
14. Do you think your patients, or their legal guardians would consent to a TH study at Albany?
15. Do you have any concerns regarding the implementation of TH at Albany?
16. Are there any other thoughts that you would like to share with us regarding TH at Albany?

Thank you for your contribution

Appendix 3: Tunstall myClinic® Post-Study Questionnaire for Healthcare Professionals

Section A: Experience to date

Has your understanding of TH changed since the THS has was implemented?
Follow-up: Did it help you do your job?

1. **Tell me about any of your previous experience/s of THSs?**
   Follow-up: Using technology to support current work processes

2. **If you have had any previous experiences of THSs, how has this experience with this system been similar or different to your previous experience?**
   Follow-up: Technology/System comparison – Why? How?

3. **Can you comment on any training or information that you received on the THS in terms of it adequacy to support your usage? How would you have changed anything to enhance the effectiveness of training?**
   Follow-up: Relevance and Adequacy

4. **What did you think of the technology of the THS implemented at AL?**
   Follow-up: Peripheral devices, ICP triage manager, Rapid Response Support

5. **What challenges did you identify during the pre-implementation of the THS? Have you experienced any of these challenges in using the system?**
   Follow-up: How much time does it take/day or/week?

6. **Can you describe any form of resistance, if any, by residents to using THS at AL? How do you think we could motivate residents in the future to use the THS?**
   Follow-up: Blood pressure Cuff

7. **How would you describe the level of ease or difficulty to incorporate a THS into your daily work? Can you tell me about any challenges that you faced**

whilst using it?

8. **What do you think the impact of the THS was on the residents at Albany? Why do you think that TH had this impact on the residents at Albany?**

9. **How has TH impacted on you? Was the impact of the THS on you as expected?**

10. **What do you think the impact of the THS was on AL's service levels? Why do you think that TH would have had this impact on the AL service levels?**

11. **Did you encounter any of initial concerns you may have had about using the THS at AL? Did any new concerns arise whilst using the THS?**
    Prompt: Ease of use of equipment, lack of technical support, time management, management support etc.

12. **Since the implementation of the THS, can you describe the level of support from management to facilitate the usage of the system?**

Section B: Future of TH Service

13. **Considering the THS implemented, describe the level of priority that a THS should be to a care home? Why do you feel that it should be at that level of priority?**

14. **Considering the THS implemented, how important a system is it to you? Why? How supportive did you find it to assist you with your work?**

Follow-up: On a scale of 1-10 with 10 being extremely important

15. **Looking back, what would you have done differently to ensure the success of the THS at AL?**

16. **What would you like management to do differently to support the success of this service?**

17. **Considering the THS implemented, how confident are you that this service will succeed and continue?**
    Follow-up: On a scale of 1-10 with 10 being extremely confident

18. **Considering the THS implemented, would YOU do anything differently? Why would you make this change?**

19. **Considering the THS implemented, what do you feel is the most suited type of patients or conditions, in your opinion, for this service?**
    Follow-up: age, ethnicity, have carers, partners, etc.

20. **Considering the THS implemented, how successful do you think the THS at Albany was? Would you like to continue to use it?**
    Prompt: Scale 0-10. Yes or No. Why?

Section C: Healthcare Professional System Usability Scale (SUS)

1. I think that I would like to use the THS frequently.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

2. I found the THS unnecessarily complex.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

3. I thought this THS was easy to use.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

4. I think that I would need assistance to be able to use this THS.

Strongly Disagree				**Strongly Agree**
1	2	3	4	5

5. I found the various functions of this THS were well integrated.

Strongly Disagree **Strongly Agree**

1		2	3	4	5

6. I thought there was too much inconsistency when using the THS.

Strongly Disagree **Strongly Agree**

1	2	3	4	5

7. I would imagine that most people would learn to use the THS very quickly.

Strongly Disagree **Strongly Agree**

1	2	3	4	5

8. I found the THS very cumbersome/awkward to use

Strongly Disagree **Strongly Agree**

1	2	3	4	5

9. I felt very confident using the THS.

Strongly Disagree **Strongly Agree**

1	2	3	4	5

10. I needed to learn a lot of things before I could get going with this THS.

Strongly Disagree **Strongly Agree**

1	2	3	4	5

Appendix 4: Tunstall myClinic® Frequency of Residents per Medication Class per Phase

Classes	CP (n=27)		AMP (n=27)		CP (n=14)		AMP (n=14)		AMTAP (n=14)	
	n	f	n	f	n	f	n	f	n	f
5α-Reductase Inhibitors	1	1	1	1	0	0	0	0	0	0
ACE- Inhibitors	5	5	3	3	4	4	2	2	2	2
Aminosalicylates	1	1	1	1	0	0	0	0	0	0
Analgesics - Non-Opioid	18	18	18	18	8	8	7	7	8	8
Analgesics – Opioid	8	10	8	8	5	6	4	4	5	5
Angiotensin II Receptor Antagonists	1	1	1	1	0	0	0	0	0	0
Antifungals - Polyene	0	0	0	0	0	0	0	0	2	2
Antibacterial – Cephalosporin	1	4	1	1	0	0	0	0	0	0
Antibacterial – Macrolide	0	0	6	6	0	0	1	1	3	3
Antibacterial - Nitroimidazole	2	2	2	2	0	0	0	0	1	1
Antibacterial - Other	1	3	3	3	0	0	0	0	1	1
Antibacterial - Penicillin	3	5	11	12	1	3	4	4	4	4
Antibacterial - Penicillinase Resistant	1	1	6	6	0	0	2	2	0	0
Antibacterial - Tetracycline	0	0	1	1	0	0	1	1	1	1
Antibacterial - Urinary Tract Infection	1	1	3	3	0	0	0	0	4	4
Anticholinergic	1	1	1	1	1	1	1	1	1	1
Anticholinesterases - Centrally Acting	2	2	3	3	2	2	2	2	1	1

Antidepressant - Serotonin Uptake Inhibitors	1	1	1	1	1	1	1	1	1	1
Antidepressants – SSRI	4	4	3	3	3	3	2	2	2	2
Antidepressants – Tetracyclic	2	2	2	2	1	1	0	0	0	0
Antidepressants – Tricyclic	1	1	1	1	0	0	1	1	1	1
Antiepileptic	4	4	4	4	1	1	1	1	1	1
Antihistamine – Non-Sedating	0	0	1	1	0	0	0	0	0	0
Antihistamine – Sedating	1	1	3	3	1	1	0	0	0	0
Antipsychotic - 2nd Generation	2	3	1	1	1	2	1	1	1	1
Antithrombotic - Vit K Antagonist	3	7	3	7	1	3	1	3	1	1
Antithrombotic – Antiplatelet	10	10	9	10	6	6	5	6	5	6
Antithrombotic - Factor XA Inhibitors	0	0	0	0	0	0	0	0	1	1
Antiviral - Nucleoside Analogues	0	0	1	1	0	0	1	1	0	0
Anxiolytics – Benzodiazepines	2	2	2	2	1	1	1	1	1	1
Benzodiazepines	4	5	3	3	3	4	2	2	2	2
Biguanides	1	1	1	1	1	1	1	1	1	1
Bisphosphonate	4	4	4	4	3	3	3	3	3	3
Calcium and Vitamin D Supplement	10	10	10	10	3	3	3	3	3	3
Calcium-Channel Blocker	5	5	4	4	3	3	3	3	3	3
Cardiac Glycoside	1	1	1	1	1	1	1	1	1	1

Corticosteroids	1	2	1	2	0	0	0	0	0	0
Diuretics – Loop	2	2	2	2	0	0	0	0	0	0
Diuretics – Thiazides	3	3	3	3	3	3	3	3	2	2
Dopamine Precursor	2	2	2	2	1	1	1	1	1	1
Dopamine Receptor Antagonists	1	2	1	2	1	2	3	4	1	1
Dopaminergic NMDA Receptor Antagonists	4	4	4	4	2	2	2	2	2	2
Electrolyte and Minerals - Potassium	1	1	1	1	0	0	0	0	0	0
Folate Supplement	6	6	7	7	2	2	2	2	1	1
H2-Receptor Antagonists	5	5	5	5	0	0	0	0	0	0
Hormone Antagonists- Aromatase Inhibitors	1	1	1	1	1	1	1	1	1	1
Insulin - Long Acting	1	1	1	1	1	2	1	1	1	1
Insulin - Rapid Acting	1	1	1	1	0	0	1	1	1	1
Iron Supplement	4	4	5	5	2	2	2	2	2	2
Laxative - Osmotic	16	16	16	16	8	8	8	8	8	8
Laxative - Stimulant	15	15	15	15	7	7	7	7	8	8
Laxatives - Softening	4	4	5	5	3	3	3	3	3	3
Muscle Relaxants - Centrally Acting	1	1	1	1	0	0	0	0	0	0
Non-Benzodiazepine Sedatives*+	2	2	0	0	1	1	0	0	1	1
Nutrients - Sugars	0	0	0	0	0	0	0	0	1	1
Physiological Saline	0	0	1	1	0	0	1	1	0	0

Proton Pump Inhibitors	7	7	7	7	5	5	5	5	5	5
Statins	10	10	10	10	8	8	8	8	7	7
Sulfonylureas	1	1	0	0	1	1	0	0	0	0
Thyroid Hormones	2	3	2	4	1	2	1	2	1	1
Vitamin B Supplement	2	3	3	3	1	2	1	2	1	1
Vitamin D Supplement	5	5	3	3	1	1	0	0	1	1
α + β Andrenoceptor Blocker	1	1	1	2	1	1	1	2	1	1
α Andrenoceptor Blocker	2	2	2	2	0	0	0	0	0	0
β Andrenoceptor Blocker – Selective	1	1	1	1	1	1	1	1	1	1
β1 Andrenoceptor Blocker – Selective	1	1	1	1	1	1	1	1	1	1
B2 Andrenoceptor Agonist – Selective Short Acting	1	1	1	1	0	0	0	0	0	0

Appendix 5: Tunstall myClinic® Medication Risk Table Control Phase

Patient	Drug	Formulation	Dose	Frequency	Duration	Class	High Risk Level	Falls Risk Level	Anticholinergic Risk Scale
AL1	Atorvastatin	Tablets	40mg	on	Ongoing	Statins	Low	Low	0
AL1	Aspirin	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL1	Levetiracetam	Tablets	250mg	bd	Ongoing	Antiepileptic	High	High	0
AL1	Omeprazole	Capsules	20mg	od	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL1	Amoxicillin	Suspension	500mg	tds	5 Days	Antibacterial - Penicillin	Low	Low	0
AL1	Amoxicillin	Suspension	500mg	tds	5 Days	Antibacterial - Penicillin	Low	Low	0
AL1	Amoxicillin	Suspension	500mg	tds	5 Days	Antibacterial - Penicillin	Low	Low	0
AL2	Zopiclone	Tablets	3.75mg	on	Stopped 7/4/16	Non-Benzodiazepine Sedatives	High	High	1
AL2	Co-Codamol	Tablets	8/500mg	qds	Stopped 7/4/16	Analgesics - Opioid	High	High	1
AL2	Buprenorphine	Patch	5mcg/hr	weekly	Ongoing	Analgesics - Opioid	High	High	0
AL2	Lactulose	Suspension	10ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL2	Letrozole	Tablets	2.5mg	od	Ongoing	Hormone Antagonists- Aromatase Inhibitors	Low	Low	0
AL2	Paracetamol	Suspension	1g	qds	Prn	Analgesics - Non-Opioid	Low	Low	0
AL3	Cholecalciferol	Tablets	20000 IU	M,W,F	Stopped 6/7/16				
AL3	Amitriptyline	Tablets	10mg	on	Ongoing	Antidepressants - Tricyclic	High	High	3
AL3	Bendroflumethiazide	Tablets	2.5	om	Ongoing	Diuretics - Thiazides	High	High	0
AL3	Lactulose	Suspension	15ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL3	Lansoprazole Orodisp	Tablets	15mg	om	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL3	Memantine	Tablets	20	om	Ongoing	Dopaminergic NMDA Receptor Antagonists	High	High	0
AL3	Paracetamol	Suspension	1g	qds	prn	Analgesics - Non-Opioid	Low	Low	0
AL3	Ramipril 2.5mg/5ml SF	Solution	10ml	od	Ongoing	ACE- Inhibitors	High	High	0
AL3	Simvastatin	Tablets	20	on	Ongoing	Statins	Low	Low	0
AL3	Aspirin Dispersible	Tablets	75	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0

AL4	Citalopram	Tablets	10mg	od	Stopped 30/3/16	Antidepressants – SSRI	High	High	1
AL4	Gliclazide	Tablets	160mg	bd	Stopped 30/3/16	Sulfonylureas	High	High	0
AL4	Risperidone	Tablets	0.5mg	on	Stopped 30/3/16	Antipsychotic - 2nd Generation	High	High	1
AL4	Simvastatin	Tablets	20mg	on	Stop-24/11/16	Statins	Low	Low	0
AL4	Promethazine	Tablets	25mg	bd	Stop-24/11/16	Antihistamine - Sedating	High	High	3
AL4	Rivastigmine	Capsules	1.5mg	bd	Stop-18/09/16	Anticholinesterases - Centrally Acting	High	High	0
AL4	Ferrous Fumarate	Tablets	210mg	tds	Stop-24/11/16	Iron Supplement	Low	Low	0
AL4	Folic Acid	Tablets	5mg	od	Stop-24/11/16	Folate Supplement	Low	Low	0
AL4	Lorazepam	Tablets	0.5mg	on	prn	Benzodiazepines	High	High	1
AL4	Co-Codamol EFF	Tablets	15mg/500mg	qds	Ongoing	Analgesics - Opioid	High	High	1
AL4	Olanzapine	Tablets	2.5mg	nocte	Ongoing	Antipsychotic - 2nd Generation	High	High	3
AL4	Metformin	Tablets	500mg	bd	Ongoing	Biguanide	High	High	0
AL4	Amlodipine	Tablets	10mg	om	Ongoing	Calcium-Channel Blocker	Low	Low	0
AL5	Co-Codamol	Tablets	15mg/500mg	qds prn	Stopped 14/6/16	Analgesics - Opioid	High	High	1
AL5	Ramipril	Capsules	2.5mg	od	Stopped 14/6/16	ACE- Inhibitors	High	High	0
AL5	Diazepam	Tablets	10mg	on	Stopped 14/6/16	Benzodiazepines	High	High	1
AL5	Atorvastatin	Tablets	40mg	on	Ongoing	Statins	Low	Low	0
AL5	Clopidogrel	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	High	High	0
AL5	Amlodipine	Tablets	5mg	om	Ongoing	Calcium-Channel Blocker	Low	Low	0
AL5	Alendronic Acid	Tablets	70mg	weekly	Ongoing	Bisphosphonate	Low	Low	0
AL5	Memantine	Tablets	10mg	od	Ongoing	Dopaminergic NMDA Receptor Antagonists	High	High	0
AL5	Lorazepam	Tablets	0.5mg	17h00	Ongoing	Benzodiazepines	High	High	1
AL5	Paracetamol	Tablets	1000mg	qds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL5	Laxido	Sachets	1 sachet	od	Ongoing	Laxative - Osmotic	Low	Low	0

AL5	Senna	Tablets	7.5mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL6	Lisinopril	Tablets	5mg	om	Ongoing	ACE- Inhibitors	High	High	1
AL6	Lantus Insulin Solostar 3ml	Injection	20units	on	Ongoing	Insulin - Long Acting	Low	Low	0
AL6	Novorapid	Injection	14 Units	tds	Ongoing	Insulin - Rapid Acting	Low	Low	0
AL6	Omeprazole GR	Tablets	20mg	od	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL6	Bisacodyl GR EC	Tablets	5mg	on prn	Ongoing	Laxative - Stimulant	Low	Low	0
AL6	Aspirin	Tablets	75mg	od	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL6	Atorvastatin	Tablets	20mg	on	Ongoing	Statins	Low	Low	0
AL6	Amlodipine	Tablets	5mg	od	Ongoing	Calcium-Channel Blocker	Low	Low	0
AL6	Carvedilol	Tablets	6.25mg	on	Ongoing	α + β Andrenoceptor Blocker	High	High	1
AL6	Bendroflumethiazide	Tablets	2.5mg	om	Stop-12/10/2016	Diuretics - Thiazides	High	High	0
AL7	Co-Dydramol 10/500	Tablets	1 or 2	qds prn	Ongoing	Analgesics - Opioid	High	High	1
AL7	Vitamin B Compound Strong	Tablets	1	om	Ongoing	Vitamin B Supplement	Low	Low	0
AL7	Folic Acid	Tablets	5mg	om	Ongoing	Folate Supplement	Low	Low	0
AL7	Senna	Tablets	7.5-15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL7	Thiamine	Tablets	100mg	om	Ongoing	Vitamin B Supplement	Low	Low	0
AL8	Sertraline Tablets	Tablets	100mg	om	Ongoing	Antidepressants - SSRI	High	High	1
AL8	Docusate sodium	Capsules	100mg	od	Ongoing	Laxatives - Softening	Low	Low	0
AL8	Alendronic Acid	Tablets	70mg	weekly	Ongoing	Bisphosphonate	Low	Low	0
AL8	Laxido Orange SF	Sachets	1	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL8	Paracetamol	Tablets	500-1000mg	prn	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL8	Fentanyl	Patch	50mcg/hr	72hrs	Ongoing	Analgesics - Opioid	High	High	1
AL9	Glycerol Suppository Adult 4g	Suppository	2	prn	Prn	Laxative - Stimulant	Low	Low	0
AL9	Laxido Orange SF	Sachets	1	bd	Prn	Laxative - Osmotic	Low	Low	0
AL9	Omeprazole GR	Capsules	10mg	om	Ongoing	Proton Pump Inhibitors	Low	Low	0

AL9	Warfarin 1mg	Tablets	1	bd	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL9	Warfarin 3mg	Tablets	1	od	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL9	Warfarin 5mg	Tablets	1	od	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL9	Paracetamol	Tablets	1 or 2	qds	Prn	Analgesics - Non-Opioid	Low	Low	0
AL9	Docusate Sodium	Capsules	200mg	prn	Prn	Laxatives - Softening	Low	Low	0
AL9	Solifenacin 10mg tabs	Tablets	10mg	od	Ongoing	Anticholinergics	High	High	3
AL9	Bisoprolol 1.25mg	Tablets	1	od	Ongoing	β1 Andrenoceptor Blocker - Selective	High	High	0
AL9	Digoxin	Tablets	125mcg	od	If pulse>60	Cardiac Glycoside	High	High	1
AL9	Simvastatin	Tablets	20mg	on	Stop-12/10/2016	Statins	Low	Low	0
AL10	Paracetamol	Tablets	1000mg	qds	Stopped 5/4/2016	Analgesics - Non-Opioid	Low	Low	0
AL10	Colecal 400U + Calcium Carb 15g EFF	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL10	Docusate Sodium	Capsules	100mg	nocte	Ongoing	Laxatives - Softening	Low	Low	0
AL11	Aspirin	Tablets	75mg	od	Stopped 15/07/2016	Antithrombotic - Antiplatelet	Low	Low	0
AL11	Lisinopril	Tablets	2.5mg	od	Stopped 15/07/2016	ACE- Inhibitors	High	High	1
AL11	Lorazepam	Tablets	0.5mg	prn	Stopped 15/07/2016	Benzodiazepines	High	High	1
AL11	Ropinirole MR	Tablets	6mg	od	Ongoing	Dopamine Receptor Antagonists	High	High	2
AL11	Atorvastatin	Tablets	10mg	nocte	Ongoing	Statins	Low	Low	0
AL11	Lactulose	Suspension	10ml	nocte	Ongoing	Laxative - Osmotic	Low	Low	0
AL11	Senna	Tablets	15mg	nocte	Ongoing	Laxative - Stimulant	Low	Low	0
AL11	Amantadine	Capsules	100mg	daily	Stop-14/09/2016	Dopamine Receptor Antagonists	High	High	2
AL11	Co-Careldopa	Tablets	125mg	tds	Ongoing	Dopamine Precursor	High	High	1

AL11	Rivastigmine	Capsules	3mg	bd	Ongoing	Anticholinesterases - Centrally Acting	High	High	3
AL12	Laxido Orange	Sachets	1	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL12	Adcal-D3	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL12	Levothyroxine Sodium	Tablets	25mcg	om	Ongoing	Thyroid Hormones	Low	Low	0
AL12	Levothyroxine Sodium	Tablets	50mcg	om	Ongoing	Thyroid Hormones	Low	Low	0
AL12	Senna	Suspension	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL12	Trazodone	Capsules	50mg	bd	Ongoing	Antidepressant - Serotonin Uptake Inhibitors	High	High	1
AL12	Paracetamol	Suspension	1000mg	qds	Prn	Analgesics - Non-Opioid	Low	Low	0
AL12	Diazepam Rectal	Solution	5mg	prn	Ongoing	Anxiolytics - Benzodiazepines	High	High	1
AL13	Colecal 400IU + Calcium Carb 1.5g	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL13	Alendronic Acid	Tablets	70mg	weekly	Ongoing	Bisphosphonate	Low	Low	0
AL13	Atorvastatin	Tablets	40mg	on	Ongoing	Statins	Low	Low	0
AL13	Bisoprolol	Tablets	1.25mg	om	Ongoing	β Andrenoceptor Blocker - Selective	High	High	0
AL13	Clopidogrel	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL13	Indapamide	Tablets	2.5mg	od	Ongoing	Diuretics - Thiazides	High	High	0
AL13	Lactulose	Suspension	10ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL13	Lansoprazole	Capsules	15mg	od	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL13	Ferrous Fumarate	Tablets	210mg	bd	Ongoing	Iron Supplement	Low	Low	0
AL14	Paracetamol	Tablets	500mg	4-6H	Prn	Analgesics - Non-Opioid	Low	Low	0
AL14	Sertraline	Tablets	50mg	om	Ongoing	Antidepressants - SSRI	High	High	1
AL14	Senna	Tablets	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL15	Amoxicillin	Suspension	500mg	tds	7 Days	Antibacterial - Penicillin	Low	Low	0
AL15	Cholecalciferol (VitD3)	Drops	1600 units	om	Ongoing	Vitamin D Supplement	Low	Low	0
AL15	Furosemide	Solution	5ml	alt days	Ongoing	Diuretics - Loop	High	High	1
AL15	Memantine	Solution	15mg	om	Ongoing	Dopaminergic NMDA Receptor Antagonists	High	High	0
AL15	Mirtazapine Orodisp	Tablets	15mg	on	Ongoing	Antidepressants - Tetracyclic	High	High	1
AL15	Paracetamol	Solution	1000mg	prn	Ongoing	Analgesics - Non-Opioid	Low	Low	0

AL15	Salbutamol	Inhaler	100mcg	prn	Ongoing	β_2 Adrenoceptor Agonists - Short Acting	Low	Low	0
AL15	Senna	Solution	15mg	prn	Ongoing	Laxative - Stimulant	Low	Low	0
AL15	Sodium Valproate	Tablets	150mg	bd	Ongoing	Antiepileptic	High	High	0
AL16	Colecal 400IU + Calcium Carb 1.5g Lemon Chew	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL16	Bisacodyl	Tablets	5mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL16	Paracetamol	Tablets	1000mg	qds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL17	Baclofen	Solution	10mg	tds	Ongoing	Muscle Relaxants - Centrally Acting	High	High	2
AL17	Ferrous Fumarate	Tablets	210mg	tds	Ongoing	Iron Supplement	Low	Low	0
AL17	Flucloxacillin	Capsules	500mg	qds	7 Days	Antibacterial - Penicillinase Resistant	Low	Low	0
AL17	Lactulose 3.1-3.7g/5ml	Solution	15ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL17	Paracetamol	Suspension	1g	qds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL18	Aspirin	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL18	Buprenorphine	Patch	10mcg/hr	weekly	Ongoing	Analgesics - Opioid	High	High	0
AL18	Cephalexin (x 3)	Suspension	125mg	on	Ongoing	Antibacterial - Cephalosporins	Low	Low	0
AL18	Lactulose 3.1-3,7mg/ml	Suspension	10ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL18	Lansoprazole Orodisp	Tablets	15mg	om	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL18	Paracetamol	Suspension	750mg	tds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL18	Promethazine	Suspension	25mg	bd	Ongoing	Antihistamine - Sedating	High	High	3
AL19	Amoxicillin	Suspension	500mg	tds	5 Days	Antibacterial - Penicillin	Low	Low	0
AL19	Adcal-D3	Dissolve Eff	2	od	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL19	Aspirin	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL19	Ranitidine	Tablets	300mg	od	Ongoing	H_2-Receptor Antagonists	Low	Low	0
AL19	Tamsulosin MR	Capsules	400mcg	od	Ongoing	α- Adrenoceptor Blockers	High	High	1
AL19	Paracetamol	Tablets	1000mg	qds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL19	Lactulose 3.1-3,7mg/ml	Suspension	10ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL19	Co-Codamol	Tablets	30mg/500mg	qds	Ongoing	Analgesics - Opioid	High	High	1
AL19	Cholecalciferol	Capsules	60000 units	weekly	5 Weeks	Vitamin D Supplement	Low	Low	0

AL20	Trimethoprim	Tablets	200mg	bd	7 Days	Antibacterial - Other	Low	Low	0
AL20	Zopiclone	Tablets	7.5mg	on prn	Stopped 4/05/2016	Non-Benzodiazepine Sedatives	High	High	1
AL20	Colecal 400IU + Calcium Carb 1.5g	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL20	Folic Acid	Tablets	5mg	om	Ongoing	Folate Supplement	Low	Low	0
AL20	Paracetamol	Tablets	1000mg	on	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL20	Senna	Tablets	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL21	Colecal 400IU + Calcium Carb 1.5g	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL21	Folic Acid	Tablets	5mg	od	Ongoing	Folate Supplement	Low	Low	0
AL21	Laxido Orange	Sachets	1	od	Ongoing	Laxative - Osmotic	Low	Low	0
AL21	Memantine	Tablets	10mg	od	Ongoing	Dopaminergic NMDA Receptor Antagonists	High	High	0
AL21	Senna	Tablets	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL21	Trazadone	Capsules	50mg	om	Ongoing	Antidepressants - SSRI	High	High	1
AL22	Amlodipine 5mg tablets	Tablets	5mg	on	Stopped 27/07/2016	Calcium-Channel Blocker	Low	Low	0
AL22	Colecal 400IU + Calcium Carb 1.5g	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL22	Aspirin Dispersible	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL22	Bisacodyl	Tablets	5mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL22	Clobazam	Suspension	10mg	on	Ongoing	Benzodiazepines	High	High	0
AL22	Cholecalciferol (Vit D3) 800U	Capsules	1	tds	Ongoing	Vitamin D Supplement	Low	Low	0
AL22	Diazepam Rectal	Solution	5mg	prn	Ongoing	Anxiolytics - Benzodiazepines	High	High	1
AL22	Laxido Orange	Sachets	1	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL22	Levetiracetam	Suspension	600mg	bd	Ongoing	Antiepileptic	High	High	0
AL22	Paracetamol	Suspension	1000mg	qds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL22	Ramipril	Capsules	1.25mg	od	Ongoing	ACE- Inhibitors	High	High	0
AL22	Ranitidine 75mg/5ml	Suspension	10ml	bd	Ongoing	H_2-Receptor Antagonists	Low	Low	0
AL22	Sandoz-K Effervescent	Tablets	2	od	Ongoing	Electrolyte and Minerals - Potassium	Low	Low	0
AL23	Buprenorphine	Patch	5mcg/hr	weekly	Ongoing	Analgesics - Opioid	High	High	0
AL23	Colecal 200IU + Calcium Carbonate 1.25g	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL23	Co-Beneldopa	Capsules	12.5mg/50mg	tds	Ongoing	Dopamine Precursor	High	High	1
AL23	Docusate Sodium	Capsules	100mg	bd	Ongoing	Laxatives - Softening	Low	Low	0

AL23	Folic Acid	Tablets	5mg	od	Ongoing	Folate Supplement	Low	Low	0
AL23	Gabapentin	Capsules	300mg	bd	Ongoing	Antiepileptic	High	High	0
AL23	Laxido Orange SF 13.6g	Sachets	1	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL23	Mirtazapine	Tablets	45mg	on	Ongoing	Antidepressants - Tetracyclic	High	High	1
AL23	Prednisolone	Tablets	1mg	om	Ongoing	Corticosteroids	High	Low	1
AL23	Prednisolone	Tablets	5mg	om	Ongoing	Corticosteroids	High	Low	1
AL23	Ranitidine	Tablets	150mg	bd	Ongoing	H_2-Receptor Antagonists	Low	Low	0
AL23	Thiamine	Tablets	50mg	od	Ongoing	Vitamin B Supplement	Low	Low	0
AL23	Warfarin	Tablets	1mg	bd	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL23	Warfarin	Tablets	3mg	bd	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL23	Co-Codamol 8mg/500mg	Tablets	2	tds	Stopped 27/07/2016	Analgesics - Opioid	High	High	1
AL23	Nitrofurantoin MR	Capsules	100mg	bd	7 Days	Antibacterial - Urinary Tract Infection	Low	Low	0
AL24	Candesartan	Tablets	4mg	od	Ongoing	Angiotensin II Receptor Antagonists	High	High	0
AL24	Donepezil	Tablets	5mg	on	Ongoing	Anticholinesterases - Centrally Acting	High	High	0
AL24	Doxazosin	Tablets	1mg	bd	Ongoing	α- Adrenoceptor Blockers	High	High	0
AL24	Finasteride	Tablets	5mg	om	Ongoing	5α-Reductase Inhibitors	High	High	0
AL24	Furosemide	Tablets	20mg	om	Ongoing	Diuretics - Loop	High	High	1
AL24	Lactulose Solution	Suspension	20ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL24	Omeprazole	Tablets	20mg	om	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL24	Paracetamol	Tablets	1000mg	qds prn	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL24	Ranitidine	Tablets	150mg	bd	Ongoing	H_2-Receptor Antagonists	Low	Low	0
AL24	Senna	Tablets	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL24	Simvastatin	Tablets	20mg	on	Ongoing	Statins	Low	Low	0
AL24	Warfarin	Tablets	3mg	bd	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL24	Warfarin	Tablets	1mg	od	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL25	Amlodipine	Tablets	5mg	om	Ongoing	Calcium-Channel Blocker	Low	Low	0
AL25	Aspirin 75mg	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0

AL25	Cholecalciferol (VitD3)	Capsules	800U	om	Ongoing	Vitamin D Supplement	Low	Low	0
AL25	Ferrous Fumarate	Tablets	210mg	od	Ongoing	Iron Supplement	Low	Low	0
AL25	Folic Acid	Tablets	5mg	om	Ongoing	Folate Supplement	Low	Low	0
AL25	Levothyroxine	Tablets	100mcg	om	Ongoing	Thyroid Hormones	Low	Low	0
AL25	Macrogol oral powder	Sachets	1	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL25	Paracetamol Tablets	Tablets	1000mg	qds prn	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL25	Ranitidine	Tablets	150mg	bd	Ongoing	H_2-Receptor Antagonists	Low	Low	0
AL25	Risedronate	Tablets	35mg	weekly	Ongoing	Bisphosphonate	Low	Low	0
AL25	Senna	Tablets	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL25	Simvastatin	Tablets	20mg	on	Ongoing	Statins	Low	Low	0
AL26	Paracetamol	Tablets	500mg	tds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL26	Sulfasalazine	Tablets	500mg	TDS	Ongoing	Aminosalicylates	Low	Low	0
AL26	Quetiapine 25mg tablets	Tablets	25mg	on	Stopped 4/5/2016	Antipsychotic - 2nd Generation	High	High	3
AL26	Senna	Solution	15mg	bd	Stopped 4/5/2016	Laxative - Stimulant	Low	Low	0
AL27	Colecal 400IU + Calcium Carb 1.5G	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0

Appendix 6: Tunstall myClinic® Medication Risk Table Active Monitoring Phase

Patient	Drug	Formulation	Dose	Frequency	Duration	Class	High Risk Level	Falls Risk Level	Anticholinergic Risk Scale
AL1	Atorvastatin	Tablets	40mg	on	Ongoing	Statins	Low	Low	0
AL1	Aspirin	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL1	Levetiracetam	Tablets	250mg	bd	Ongoing	Antiepileptic	High	High	0
AL1	Omeprazole	Capsules	20mg	od	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL1	Amoxicillin	Suspension	500mg	tds	5 Days	Antibacterial - Penicillin	Low	Low	0
AL2	Buprenorphine	Patch	5mcg/hr	weekly	Ongoing	Analgesics - Opioid	High	High	0
AL2	Lactulose	Suspension	10ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL2	Letrozole	Tablets	2.5mg	od	Ongoing	Hormone Antagonists- Aromatase Inhibitors	Low	Low	0
AL2	Paracetamol	Suspension	1g	qds	Prn	Analgesics - Non-Opioid	Low	Low	0
AL3	Amitriptyline	Tablets	10mg	on	Ongoing	Antidepressants - Tricyclic	High	High	3
AL3	Bendroflumethiazide	Tablets	2.5	om	Ongoing	Diuretics - Thiazides	High	High	0
AL3	Lactulose	Suspension	15ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL3	Lansoprazole Orodisp	Tablets	15mg	om	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL3	Memantine	Tablets	20	om	Ongoing	Dopaminergic NMDA Receptor Antagonists	High	High	0
AL3	Paracetamol	Suspension	1g	qds	prn	Analgesics - Non-Opioid	Low	Low	0
AL3	Ramipril 2.5mg/5ml SF	Solution	10ml	od	Ongoing	ACE- Inhibitors	High	High	0
AL3	Simvastatin	Tablets	20	on	Ongoing	Statins	Low	Low	0
AL3	Aspirin Dispersible	Tablets	75	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL4	Simvastatin	Tablets	20mg	on	Stop-24/11/16	Statins	Low	Low	0
AL4	Promethazine	Tablets	25mg	bd	Stop-24/11/16	Antihistamine - Sedating	High	High	3
AL4	Rivastigmine	Capsules	1.5mg	bd	Stop-18/09/16	Anticholinesterases - Centrally Acting	High	High	0
AL4	Ferrous Fumarate	Tablets	210mg	tds	Stop-24/11/16	Iron Supplement	Low	Low	0

AL4	Folic Acid	Tablets	5mg	od	Stop-24/11/16	Folate Supplement	Low	Low	0
AL4	Amoxicillin SF	Suspension	500mg	tds	5 Days	Antibacterial - Penicillin	Low	Low	0
AL4	Steripoules saline 0.9% 2.5ml	Suspension	2.5ml	tds	5 Days	Physiological Saline	Low	Low	0
AL4	Lorazepam	Tablets	0.5mg	on	prn	Benzodiazepines	High	High	1
AL4	Co-Codamol EFF	Tablets	15mg/500mg	qds	Ongoing	Analgesics - Opioid	High	High	1
AL4	Olanzapine	Tablets	2.5mg	nocte	Ongoing	Antipsychotic - 2nd Generation	High	High	3
AL4	Metformin	Tablets	500mg	bd	Ongoing	Biguanide	High	High	0
AL4	Amlodipine	Tablets	10mg	om	Ongoing	Calcium-Channel Blocker	Low	Low	0
AL5	Atorvastatin	Tablets	40mg	on	Ongoing	Statins	Low	Low	0
AL5	Clopidogrel	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	High	High	0
AL5	Amlodipine	Tablets	5mg	om	Ongoing	Calcium-Channel Blocker	Low	Low	0
AL5	Alendronic Acid	Tablets	70mg	weekly	Ongoing	Bisphosphonate	Low	Low	0
AL5	Memantine	Tablets	10mg	od	Ongoing	Dopaminergic NMDA Receptor Antagonists	High	High	0
AL5	Lorazepam	Tablets	0.5mg	17h00	Ongoing	Benzodiazepines	High	High	1
AL5	Paracetamol	Tablets	1000mg	qds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL5	Laxido	Sachets	1 sachet	od	Ongoing	Laxative - Osmotic	Low	Low	0
AL5	Senna	Tablets	7.5mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL5	Flucloxacillin	Capsules	500mg	qds	7 Days	Antibacterial - Penicillinase Resistant	Low	Low	0
AL5	Doxycycline	Capsules	100mg	bd	14 Days	Antibacterial - Tetracycline	Low	Low	0
AL5	Clarithromycin	Tablets	500mg	bd	14 Days	Antibacterial - Macrolide	Low	Low	0
AL6	Lisinopril	Tablets	10mg	om	Ongoing	ACE- Inhibitors	High	High	1
AL6	Lantus Insulin Solostar 3ml	Injection	20units	on	Ongoing	Insulin - Long Acting	Low	Low	0
AL6	Novorapid	Injection	14 Units	tds	Ongoing	Insulin - Rapid Acting	Low	Low	0
AL6	Omeprazole GR	Tablets	20mg	od	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL6	Bisacodyl GR EC	Tablets	5mg	on prn	Ongoing	Laxative - Stimulant	Low	Low	0
AL6	Aspirin	Tablets	75mg	od	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0

AL6	Atorvastatin	Tablets	20mg	on	Ongoing	Statins	Low	Low	0
AL6	Amlodipine	Tablets	5mg	od	Ongoing	Calcium-Channel Blocker	Low	Low	0
AL6	Carvedilol	Tablets	6.25mg	on	Ongoing	α + β Andrenoceptor Blocker	High	High	1
AL6	Bendroflumethiazide	Tablets	2.5mg	om	Stop-12/10/2016	Diuretics - Thiazides	High	High	0
AL6	Carvedilol	Tablets	12.5mg	om	Ongoing	α + β Andrenoceptor Blocker	High	High	1
AL6	Clopidogrel	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	High	High	0
AL6	Aciclovir tablets	Tablets	200mg	Five Daily	5 Days	Antiviral - Nucleoside Analogues	Low	Low	0
AL7	Co-Dydramol 10/500	Tablets	1 or 2	qds prn	Ongoing	Analgesics - Opioid	High	High	1
AL7	Vitamin B Compound Strong	Tablets	1	om	Ongoing	Vitamin B Supplement	Low	Low	0
AL7	Folic Acid	Tablets	5mg	om	Ongoing	Folate Supplement	Low	Low	0
AL7	Senna	Tablets	7.5-15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL7	Thiamine	Tablets	100mg	om	Ongoing	Vitamin B Supplement	Low	Low	0
AL8	Sertraline Tablets	Tablets	100mg	om	Ongoing	Antidepressants - SSRI	High	High	1
AL8	Docusate sodium	Capsules	100mg	od	Ongoing	Laxatives - Softening	Low	Low	0
AL8	Alendronic Acid	Tablets	70mg	weekly	Ongoing	Bisphosphonate	Low	Low	0
AL8	Laxido Orange SF	Sachets	1	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL8	Paracetamol	Tablets	500-1000mg	prn	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL8	Fentanyl	Patch	50mcg/hr	72hrs	Ongoing	Analgesics - Opioid	High	High	1
AL8	Amoxicillin	Suspension	500mg	tds	5 Days	Antibacterial - Penicillin	Low	Low	0
AL9	Glycerol Suppository Adult 4g	Suppository	2	prn	Prn	Laxative - Stimulant	Low	Low	0
AL9	Laxido Orange SF	Sachets	1	bd	Prn	Laxative - Osmotic	Low	Low	0
AL9	Omeprazole GR	Capsules	10mg	om	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL9	Warfarin 1mg	Tablets	1	bd	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL9	Warfarin 3mg	Tablets	1	od	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL9	Warfarin 5mg	Tablets	1	od	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1

AL9	Paracetamol	Tablets	1 or 2	qds	Prn	Analgesics - Non-Opioid	Low	Low	0
AL9	Docusate Sodium	Capsules	200mg	prn	Prn	Laxatives - Softening	Low	Low	0
AL9	Solifenacin 10mg tabs	Tablets	10mg	od	Ongoing	Anticholinergics	High	High	3
AL9	Bisoprolol 1.25mg	Tablets	1	od	Ongoing	β1 Andrenoceptor Blocker - Selective	High	High	0
AL9	Digoxin	Tablets	125mcg	od	If pulse>60	Cardiac Glycoside	High	High	1
AL9	Simvastatin	Tablets	20mg	on	Stop-12/10/2016	Statins	Low	Low	0
AL9	Amoxicillin	Suspension	500mg	tds	5 Days	Antibacterial - Penicillin	Low	Low	0
AL10	Colecal 400U + Calcium Carb 15g EFF	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL10	Docusate Sodium	Capsules	100mg	nocte	Ongoing	Laxatives - Softening	Low	Low	0
AL11	Ropinirole MR	Tablets	6mg	od	Ongoing	Dopamine Receptor Antagonists	High	High	2
AL11	Atorvastatin	Tablets	10mg	nocte	Ongoing	Statins	Low	Low	0
AL11	Lactulose	Suspension	10ml	nocte	Ongoing	Laxative - Osmotic	Low	Low	0
AL11	Senna	Tablets	15mg	nocte	Ongoing	Laxative - Stimulant	Low	Low	0
AL11	Amantadine	Capsules	100mg	daily	Stop-14/09/2016	Dopamine Receptor Antagonists	High	High	2
AL11	Co-Careldopa	Tablets	125mg	tds	Ongoing	Dopamine Precursor	High	High	1
AL11	Rivastigmine	Capsules	3mg	bd	Ongoing	Anticholinesterases - Centrally Acting	High	High	3
AL12	Laxido Orange	Sachets	1	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL12	Adcal-D3	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL12	Levothyroxine Sodium	Tablets	25mcg	om	Ongoing	Thyroid Hormones	Low	Low	0
AL12	Levothyroxine Sodium	Tablets	50mcg	om	Ongoing	Thyroid Hormones	Low	Low	0
AL12	Senna	Suspension	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL12	Trazodone	Capsules	50mg	bd	Ongoing	Antidepressant - Serotonin Uptake Inhibitors	High	High	1
AL12	Paracetamol	Suspension	1000mg	qds	Prn	Analgesics - Non-Opioid	Low	Low	0

AL12	Diazepam Rectal	Solution	5mg	prn	Ongoing	Anxiolytics - Benzodiazepines	High	High	1
AL12	Flucloxacillin	Capsules	250mg	qds	7 Days	Antibacterial - Penicillinase Resistant	Low	Low	0
AL13	Colecal 400IU + Calcium Carb 1.5g	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL13	Alendronic Acid	Tablets	70mg	weekly	Ongoing	Bisphosphonate	Low	Low	0
AL13	Atorvastatin	Tablets	40mg	on	Ongoing	Statins	Low	Low	0
AL13	Bisoprolol	Tablets	1.25mg	om	Ongoing	β Andrenoceptor Blocker - Selective	High	High	0
AL13	Clopidogrel	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL13	Indapamide	Tablets	2.5mg	od	Ongoing	Diuretics - Thiazides	High	High	0
AL13	Lactulose	Suspension	10ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL13	Lansoprazole	Capsules	15mg	od	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL13	Ferrous Fumarate	Tablets	210mg	bd	Ongoing	Iron Supplement	Low	Low	0
AL14	Paracetamol	Tablets	500mg	4-6H	Prn	Analgesics - Non-Opioid	Low	Low	0
AL14	Sertraline	Tablets	50mg	om	Ongoing	Antidepressants - SSRI	High	High	1
AL14	Senna	Tablets	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL15	Cholecalciferol (VitD3)	Drops	1600 units	om	Ongoing	Vitamin D Supplement	Low	Low	0
AL15	Furosemide	Solution	20mg	alt days	Ongoing	Diuretics - Loop	High	High	1
AL15	Memantine	Solution	15mg	om	Ongoing	Dopaminergic NMDA Receptor Antagonists	High	High	0
AL15	Mirtazapine Orodisp	Tablets	15mg	on	Ongoing	Antidepressants - Tetracyclic	High	High	1
AL15	Paracetamol	Solution	1000mg	prn	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL15	Salbutamol	Inhaler	100mcg	2 qds prn	Ongoing	β_2 Adrenoceptor Agonists - Short Acting	Low	Low	0
AL15	Senna	Solution	15mg	on prn	Ongoing	Laxative - Stimulant	Low	Low	0
AL15	Sodium Valproate	Tablets	150mg	bd	Ongoing	Antiepileptic	High	High	0
AL16	Colecal 400IU + Calcium Carb 1.5g Lemon Chew	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL16	Bisacodyl	Tablets	5mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL16	Paracetamol	Tablets	1000mg	qds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL16	Co-Dydramol	Tablets	500mg/10mg	qds	Prn	Analgesics - Opioid	High	High	1

AL16	Flucloxacillin	Capsules	500mg	qds	7 Days	Antibacterial - Penicillinase Resistant	Low	Low	0
AL17	Baclofen	Solution	10mg	tds	Ongoing	Muscle Relaxants - Centrally Acting	High	High	2
AL17	Ferrous Fumarate	Tablets	210mg	tds	Ongoing	Iron Supplement	Low	Low	0
AL17	Flucloxacillin	Capsules	500mg	qds	7 Days	Antibacterial - Penicillinase Resistant	Low	Low	0
AL17	Lactulose 3.1-3.7g/5ml	Solution	15ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL17	Paracetamol	Suspension	1g	qds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL17	Clarithromycin	Tablets	500mg	bd	5 Days	Antibacterial - Macrolide	Low	Low	0
AL17	Docusate	Suspension	200mg	od	Ongoing	Laxatives - Softening	Low	Low	0
AL17	Metronidazole	Tablets	400mg	tds	Ongoing	Antibacterial - Nitroimidazole	Low	Low	0
AL17	Amoxicillin	Suspension	500mg	tds	5 Days	Antibacterial - Penicillin	Low	Low	0
AL18	Aspirin	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL18	Buprenorphine	Patch	10mcg/hr	weekly	Ongoing	Analgesics - Opioid	High	High	0
AL18	Cephalexin 125mg/5ml	Suspension	125mg	on	Ongoing	Antibacterial - Cephalosporins	Low	Low	0
AL18	Lactulose 3.1-3,7mg/ml	Suspension	10ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL18	Lansoprazole Orodisp	Tablets	15mg	om	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL18	Paracetamol	Suspension	750mg	tds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL18	Promethazine	Suspension	25mg	bd	Ongoing	Antihistamine - Sedating	High	High	3
AL18	Clarithromycin	Suspension	500mg	bd	7 Days	Antibacterial - Macrolide	Low	Low	0
AL18	Metronidazole Liquid	Suspension	400mg	tds	5 Days	Antibacterial - Nitroimidazole	Low	Low	0
AL18	Senna	Suspension	15mg	bd	Ongoing	Laxative - Stimulant	Low	Low	0
AL18	Amoxicillin	Suspension	1000mg	qds	5 Days	Antibacterial - Penicillin	Low	Low	0
AL19	Amoxicillin	Suspension	500mg	tds	5 Days	Antibacterial - Penicillin	Low	Low	0
AL19	Adcal-D3	Dissolve Eff	2	od	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL19	Aspirin	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL19	Ranitidine	Tablets	300mg	od	Ongoing	H_2-Receptor Antagonists	Low	Low	0
AL19	Tamsulosin MR	Capsules	400mcg	od	Ongoing	α- Adrenoceptor Blockers	High	High	1

AL19	Paracetamol	Tablets	1000mg	qds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL19	Lactulose 3.1-3,7mg/ml	Suspension	10ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL19	Co-Codamol	Tablets	30mg/500mg	qds	Ongoing	Analgesics - Opioid	High	High	1
AL19	Erythromycin Ethyl Succinate	Suspension	10ml	qds	7 Days	Antibacterial - Macrolide	Low	Low	0
AL19	Nitrofurantoin MR	Capsules	100mg	bd	14 Days	Antibacterial - Urinary Tract Infection	Low	Low	0
AL20	Colecal 400IU + Calcium Carb 1.5g	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL20	Folic Acid	Tablets	5mg	om	Ongoing	Folate Supplement	Low	Low	0
AL20	Paracetamol 500mg	Tablets	1000mg	on	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL20	Senna 7.5mg tabs	Tablets	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL20	Clarithromycin	Tablets	250mg	bd	7 Days	Antibacterial - Macrolide	Low	Low	0
AL20	Cetirizine	Tablets	10mg	od	Ongoing				
AL20	Flucloxacillin	Suspension	500mg	qds	7 Days	Antibacterial - Penicillinase Resistant	Low	Low	0
AL21	Colecal 400IU + Calcium Carb 1.5g	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL21	Folic Acid	Tablets	5mg	od	Ongoing	Folate Supplement	Low	Low	0
AL21	Laxido Orange	Sachets	1	od	Ongoing	Laxative - Osmotic	Low	Low	0
AL21	Memantine	Tablets	10mg	od	Ongoing	Dopaminergic NMDA Receptor Antagonists	High	High	0
AL21	Senna	Tablets	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL21	Trazadone	Capsules	50mg	om	Ongoing	Antidepressants - SSRI	High	High	1
AL21	Nitrofurantoin MR	Capsules	100mg	bd	7 Days	Antibacterial - Urinary Tract Infection	Low	Low	0
AL21	Paracetamol	Tablets	1000mg	tds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL21	Amoxicillin	Capsules	500mg	tds	7 Days	Antibacterial - Penicillin	Low	Low	0
AL22	Colecal 400IU + Calcium Carb 1.5g	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL22	Aspirin Dispersible	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL22	Bisacodyl	Tablets	5mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL22	Clobazam	Suspension	10mg	on	Ongoing	Benzodiazepines	High	High	0

AL22	Cholecalciferol (Vit D3) 800U	Capsules	1	tds	Ongoing	Vitamin D Supplement	Low	Low	0
AL22	Diazepam Rectal	Solution	5mg	prn	Ongoing	Anxiolytics - Benzodiazepines	High	High	1
AL22	Laxido Orange	Sachets	1	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL22	Levetiracetam	Suspension	600mg	bd	Ongoing	Antiepileptic	High	High	0
AL22	Paracetamol	Suspension	1000mg	qds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL22	Ramipril	Capsules	1.25mg	od	Ongoing	ACE- Inhibitors	High	High	0
AL22	Ranitidine 75mg/5ml	Suspension	10ml	bd	Ongoing	H_2-Receptor Antagonists	Low	Low	0
AL22	Sandoz-K Effervescent	Tablets	2	od	Ongoing	Electrolyte and Minerals - Potassium	Low	Low	0
AL22	Trimethoprim	Tablets	200mg	bd	7 Days	Antibacterial - Other	Low	Low	0
AL22	Ferrous Fumarate	Tablets	210mg	bd	Stopped 12/11/6	Iron Supplement	Low	Low	0
AL23	Buprenorphine	Patch	5mcg/hr	weekly	Ongoing	Analgesics - Opioid	High	High	0
AL23	Colecal 200IU + Calcium Carbonate 1.25g	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL23	Co-Beneldopa	Capsules	12.5mg/ 50mg	tds	Ongoing	Dopamine Precursor	High	High	1
AL23	Docusate Sodium	Capsules	100mg	bd	Ongoing	Laxatives - Softening	Low	Low	0
AL23	Folic Acid	Tablets	5mg	od	Ongoing	Folate Supplement	Low	Low	0
AL23	Gabapentin	Capsules	300mg	bd	Ongoing	Antiepileptic	High	High	0
AL23	Laxido Orange SF 13.6g	Sachets	1	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL23	Mirtazapine	Tablets	45mg	on	Ongoing	Antidepressants - Tetracyclic	High	High	1
AL23	Prednisolone	Tablets	1mg	om	Ongoing	Corticosteroids	High	Low	1
AL23	Prednisolone	Tablets	5mg	om	Ongoing	Corticosteroids	High	Low	1
AL23	Ranitidine	Tablets	150mg	bd	Ongoing	H_2-Receptor Antagonists	Low	Low	0
AL23	Thiamine	Tablets	50mg	od	Ongoing	Vitamin B Supplement	Low	Low	0
AL23	Warfarin	Tablets	1mg	bd	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL23	Warfarin	Tablets	3mg	bd	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL23	Nitrofurantoin MR	Capsules	100mg	bd	7 Days	Antibacterial - Urinary Tract Infection	Low	Low	0
AL23	Erythromycin	Capsules	500mg	bd	7 Days	Antibacterial - Macrolide	Low	Low	0
AL23	Trimethoprim	Tablets	200mg	bd	7 Days	Antibacterial - Other	Low	Low	0
AL24	Candesartan	Tablets	4mg	od	Ongoing	Angiotensin II Receptor Antagonists	High	High	0
AL24	Donepezil	Tablets	5mg	on	Ongoing	Anticholinesterases - Centrally Acting	High	High	0

AL24	Doxazosin	Tablets	1mg	bd	Ongoing	α- Adrenoceptor Blockers	High	High	0
AL24	Finasteride	Tablets	5mg	om	Ongoing	5α-Reductase Inhibitors	High	High	0
AL24	Furosemide	Tablets	20mg	om	Ongoing	Diuretics - Loop	High	High	1
AL24	Lactulose Solution	Suspension	20ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL24	Omeprazole	Tablets	20mg	om	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL24	Paracetamol	Tablets	1000mg	qds prn	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL24	Ranitidine	Tablets	150mg	bd	Ongoing	H_2-Receptor Antagonists	Low	Low	0
AL24	Senna	Tablets	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL24	Simvastatin	Tablets	20mg	on	Ongoing	Statins	Low	Low	0
AL24	Warfarin	Tablets	3mg	bd	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL24	Warfarin	Tablets	1mg	od	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL24	Folic Acid	Tablets	5mg	om	Ongoing	Folate Supplement	Low	Low	0
AL24	Oxycodone	Suspension	2.5mg	qds prn	Ongoing	Analgesics – Opioid	High	High	1
AL24	Amoxicillin	Capsules	500mg	tds	5 Days	Antibacterial - Penicillin	Low	Low	0
AL24	Co-Amoxiclav	Tablets	625mg	tds	5 Days	Antibacterial - Penicillin	Low	Low	1
AL25	Amlodipine	Tablets	5mg	om	Ongoing	Calcium-Channel Blocker	Low	Low	0
AL25	Aspirin 75mg	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL25	Cholecalciferol (VitD3)	Capsules	800U	om	Ongoing	Vitamin D Supplement	Low	Low	0
AL25	Ferrous Fumarate	Tablets	210mg	od	Ongoing	Iron Supplement	Low	Low	0
AL25	Folic Acid	Tablets	5mg	om	Ongoing	Folate Supplement	Low	Low	0
AL25	Levothyroxine	Tablets	100mcg	om	Ongoing	Thyroid Hormones	Low	Low	0
AL25	Macrogol oral powder	Sachets	1	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL25	Paracetamol Tablets	Tablets	1000mg	qds prn	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL25	Ranitidine	Tablets	150mg	bd	Ongoing	H_2-Receptor Antagonists	Low	Low	0
AL25	Risedronate	Tablets	35mg	weekly	Ongoing	Bisphosphonate	Low	Low	0
AL25	Senna	Tablets	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL25	Simvastatin	Tablets	20mg	on	Ongoing	Statins	Low	Low	0

AL25	Levothyroxine	Tablets	25mcg	om	Ongoing	Thyroid Hormones	Low	Low	0
AL25	Trimethoprim	Tablets	200mg	bd x 3/7	7 Days	Antibacterial - Other	Low	Low	0
AL25	Amoxicillin	Capsules	500mg	tds	7 Days	Antibacterial - Penicillin	Low	Low	0
AL26	Paracetamol	Tablets	500mg	tds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL26	Sulfasalazine	Tablets	500mg	TDS	Ongoing	Aminosalicylates	Low	Low	0
AL26	Flucloxacillin	Capsules	250mg	qds	7 Days	Antibacterial - Penicillinase Resistant	Low	Low	0
AL27	Colecal 400IU + Calcium Carb 1.5G	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL27	Amoxicillin	Suspension	500mg	tds	7 Days	Antibacterial - Penicillin	Low	Low	0

Appendix 7: Tunstall myClinic® Medication Risk Table Active Monitoring Phase with Text Alerts

Patient	Drug	Formulation	Dose	Frequency	Duration	Class	High Risk Level	Falls Risk Level	Anticholinergic Risk Scale
AL1	Atorvastatin	Tablets	40mg	on	Ongoing	Statins	Low	Low	0
AL1	Aspirin	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL1	Levetiracetam	Tablets	500mg	bd	Ongoing	Antiepileptic	High	High	0
AL1	Omeprazole	Capsules	20mg	od	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL1	Amoxicillin	Suspension	500mg	tds	5 Days	Antibacterial - Penicillin	Low	Low	0
AL1	Paracetamol	Suspension	1g	qds	Prn	Analgesics - Non-Opioid	Low	Low	0
AL1	Trimethoprim	Tablets	200mg	bd	3 Days	Antibacterial - Other	Low	Low	0
AL1	Buprenorphine	Patch	5mg	weekly	Ongoing	Analgesics - Opioid	High	High	0
AL1	Macrogol	Sachets	1	bd	6 Days	Laxative - Osmotic	Low	Low	0
AL1	Nystatin	Suspension	4ml	qds	12 Days	Antifungals - Polyene	Low	Low	0
AL1	Senna	Tablets	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL1	Nitrofurantoin	Capsules	100mg	bd	5 Days	Antibacterial - Urinary Tract Infection	Low	Low	0
AL2	Stopped by CUH								
AL2	Lactulose	Suspension	10ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL2	Letrozole	Tablets	2.5mg	od	Ongoing	Hormone Antagonists- Aromatase Inhibitors	Low	Low	0
AL2	Paracetamol	Suspension	1g	qds	Prn	Analgesics - Non-Opioid	Low	Low	0

AL2	Nitrofurantoin	Capsules	100mg	bd	5 Days	Antibacterial - Urinary Tract Infection	Low	Low	0
AL2	Amoxicillin	Suspension	500mg	tds	7 Days	Antibacterial - Penicillin	Low	Low	0
AL2	Co-Codamol 8/500mg	Tablets	500mg	qds	prn	Analgesics - Opioid	High	High	1
AL3	Amitriptyline	Tablets	10mg	on	Ongoing	Antidepressants - Tricyclic	High	High	3
AL3	Bendroflumethiazide	Tablets	2.5	om	Ongoing	Diuretics - Thiazides	High	High	0
AL3	Lactulose	Suspension	15ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL3	Lansoprazole Orodisp	Tablets	15mg	om	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL3	Memantine	Tablets	20	om	Ongoing	Dopaminergic NMDA Receptor Antagonists	High	High	0
AL3	Paracetamol	Suspension	1g	qds	prn	Analgesics - Non-Opioid	Low	Low	0
AL3	Ramipril	Capsules	10mg	om	Ongoing	ACE- Inhibitors	High	High	0
AL3	Simvastatin	Tablets	20	on	Ongoing	Statins	Low	Low	0
AL3	Aspirin Dispersible	Tablets	75	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL3	Amoxicillin	Suspension	500mg	tds	7 Days	Antibacterial - Penicillin	Low	Low	0
AL3	Erythromycin	Suspension	125mg	qds	8 Days	Antibacterial - Macrolide	Low	Low	0
AL4	Lorazepam	Tablets	0.5mg	on	prn	Benzodiazepines	High	High	1
AL4	Co-Codamol EFF	Tablets	15mg/500 mg	qds	Ongoing	Analgesics - Opioid	High	High	1
AL4	Olanzapine	Tablets	2.5mg	nocte	Ongoing	Antipsychotic - 2nd Generation	High	High	3
AL4	Metformin	Tablets	500mg	bd	Ongoing	Biguanide	High	High	0

AL4	Amlodipine	Tablets	10mg	om	Ongoing	Calcium-Channel Blocker	Low	Low	0
AL5	Atorvastatin	Tablets	40mg	on	Ongoing	Statins	Low	Low	0
AL5	Clopidogrel	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	High	High	0
AL5	Amlodipine	Tablets	5mg	om	Ongoing	Calcium-Channel Blocker	Low	Low	0
AL5	Alendronic Acid	Tablets	70mg	weekly	Ongoing	Bisphosphonate	Low	Low	0
AL5	Memantine	Tablets	10mg	od	Ongoing	Dopaminergic NMDA Receptor Antagonists	High	High	0
AL5	Lorazepam	Tablets	0.5mg	17h00	Stop-15/08/17	Benzodiazepines	High	High	1
AL5	Paracetamol	Tablets	1000mg	qds	Ongoing	Analgesics - Non-Opioid	Low	Low	0
AL5	Laxido	Sachets	1 sachet	od	Ongoing	Laxative - Osmotic	Low	Low	0
AL5	Senna	Tablets	7.5mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL5	Erythromycin GR EC	Tablets	500mg	bd	14 Days	Antibacterial - Macrolide	Low	Low	0
AL5	Metronidazole	Tablets	400mg	tds	7 Days	Antibacterial - Nitroimidazole	Low	Low	0
AL5	Doxycycline	Capsules	200mg	od	3 Days	Antibacterial - Tetracycline	Low	Low	0
AL5	Zopiclone	Tablets	3.75mg	on	Ongoing	Non-Benzodiazepine Sedatives	High	High	1
AL5	Nitrofurantoin	Capsules	50mg	qds	10 days	Antibacterial - Urinary Tract Infection	Low	Low	0
AL6	Lisinopril	Tablets	10mg	om	Ongoing	ACE- Inhibitors	High	High	1
AL6	Lantus Insulin Solostar 3ml	Flexpen	20units	on	Ongoing	Insulin - Long Acting	Low	Low	0
AL6	Novorapid Flexpen Insulin 100U/1ml	Injection	14 Units	tds	Ongoing	Insulin - Rapid Acting	Low	Low	0
AL6	Lansoprazole Orodisp	Tablets	30mg	om	Ongoing	Proton Pump Inhibitors	Low	Low	0

AL6	Bisacodyl GR EC	Tablets	5mg	on prn	Ongoing	Laxative - Stimulant	Low	Low	0
AL6	Aspirin	Tablets	75mg	od	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL6	Atorvastatin	Tablets	20mg	on	Ongoing	Statins	Low	Low	0
AL6	Amlodipine	Tablets	5mg	od	Ongoing	Calcium-Channel Blocker	Low	Low	0
AL6	Carvedilol	Tablets	12.5mg	om	Ongoing	α + β Andrenoceptor Blocker	High	High	1
AL6	Carvedilol	Tablets	6.25mg	on	Ongoing	α + β Andrenoceptor Blocker	High	High	1
AL6	Clopidogrel	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	High	High	0
AL6	Ferrous Fumarate	Tablets	210mg	tds	Ongoing	Iron Supplement	Low	Low	0
AL6	Cholecalciferol	Capsules	20000IU	weekly	Ongoing	Vitamin D Supplement	Low	Low	0
AL6	Glucogel dextrose 40%	Gel	use	prn	Ongoing	Nutrients - Sugars	Low	Low	0
AL6	Rivaroxaban	Tablets	15mg	bd	Ongoing	Antithrombotic - Factor XA Inhibitors	High	High	0
AL7	Co-Dydramol 10/500	Tablets	1 or 2	qds prn	Ongoing	Analgesics - Opioid	High	High	1
AL7	Vitamin B Compound Strong	Tablets	1	om	Ongoing	Vitamin B Supplement	Low	Low	0
AL7	Folic Acid	Tablets	5mg	om	Ongoing	Folate Supplement	Low	Low	o
AL7	Senna	Tablets	7.5-15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL7	Thiamine	Tablets	100mg	om	Ongoing	Vitamin B Supplement	Low	Low	0
AL8	Sertraline Tablets	Tablets	100mg	om	Ongoing	Antidepressants - SSRI	High	High	1
AL8	Docusate sodium	Capsules	100mg	bd	Ongoing	Laxatives - Softening	Low	Low	0
AL8	Alendronic Acid	Tablets	70mg	weekly	Ongoing	Bisphosphonate	Low	Low	0

AL8	Stopped by GP 02/04/17						Low	Low	0
AL8	Paracetamol	Suspension	1000mg	qds	prn	Analgesics - Non-Opioid	Low	Low	0
AL8	Fentanyl	Patch	50mcg/hr	72hrs	Ongoing	Analgesics - Opioid	High	High	1
AL9	Glycerol Suppository Adult 4g	Suppository	2	prn	Prn	Laxative - Stimulant	Low	Low	0
AL9	Laxido Orange SF	Sachets	1	bd	Prn	Laxative - Osmotic	Low	Low	0
AL9	Omeprazole GR	Capsules	10mg	om	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL9	Warfarin 1mg	Tablets	1	bd	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL9	Warfarin 3mg	Tablets	1	od	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL9	Warfarin 5mg	Tablets	1	od	Ongoing	Antithrombotic - Vit K Antagonist	High	High	1
AL9	Paracetamol	Tablets	1 or 2	qds	Prn	Analgesics - Non-Opioid	Low	Low	0
AL9	Docusate Sodium	Capsules	200mg	prn	Prn	Laxatives - Softening	Low	Low	0
AL9	Solifenacin 10mg tabs	Tablets	10mg	od	Ongoing	Anticholinergics	High	High	3
AL9	Bisoprolol 1.25mg	Tablets	1	od	Ongoing	β1 Andrenoceptor Blocker - Selective	High	High	0
AL9	Digoxin	Tablets	125mcg	od	If pulse>60	Cardiac Glycoside	High	High	1
AL9	Simvastatin	Tablets	20mg	on	Stop-12/10/2016	Statins	Low	Low	0
AL9	Nitrofurantoin	Capsules	100mg	bd	5 Days	Antibacterial - Urinary Tract Infection	Low	Low	0
AL9	Amoxicillin	Suspension	1g	tds	7 Days	Antibacterial - Penicillin	Low	Low	0
AL9	Clarithromycin	Suspension	500mg	bd	7 Days	Antibacterial - Macrolide	High	Low	0
AL9	Nystatin 100,000/ml	Suspension	4ml	qds	7 Days	Antifungals - Polyene	Low	Low	0

AL10	Colecal 400U + Calcium Carb 15g EFF	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL10	Docusate Sodium	Capsules	1	nocte	Ongoing	Laxatives - Softening	Low	Low	0
AL11	Ropinirole MR	Tablets	6mg	od	Ongoing	Dopamine Receptor Antagonists	High	High	2
AL11	Atorvastatin	Tablets	10mg	nocte	Ongoing	Statins	Low	Low	0
AL11	Lactulose	Sachets	10ml	nocte	Ongoing	Laxative - Osmotic	Low	Low	0
AL11	Senna	Tablets	15mg	nocte	Ongoing	Laxative - Stimulant	Low	Low	0
AL11	Co-Careldopa	Tablets	125mg	tds	Ongoing	Dopamine Precursor	High	High	1
AL11	Rivastigmine	Capsules	3mg	bd	Ongoing	Anticholinesterases - Centrally Acting	High	High	3
AL12	Laxido Orange	Sachets	1	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL12	Adcal-D3	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL12	Levothyroxine Sodium	Tablets	25mcg	om	Ongoing	Thyroid Hormones	Low	Low	0
AL12	Levothyroxine Sodium	Tablets	50mcg	om	Ongoing	Thyroid Hormones	Low	Low	0
AL12	Senna	Suspension	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0
AL12	Trazodone	Capsules	50mg	bd	Ongoing	Antidepressant - Serotonin Uptake Inhibitors	High	High	1
AL12	Paracetamol	Suspension	1000mg	qds	Prn	Analgesics - Non-Opioid	Low	Low	0
AL12	Diazepam Rectal	Solution	5mg	prn	Ongoing	Anxiolytics - Benzodiazepines	High	High	1
AL13	Colecal 400IU + Calcium Carb 1.5g	Tablets	1	bd	Ongoing	Calcium and Vitamin D Supplement	Low	Low	0
AL13	Alendronic Acid	Tablets	70mg	weekly	Ongoing	Bisphosphonate	Low	Low	0
AL13	Atorvastatin	Tablets	40mg	on	Ongoing	Statins	Low	Low	0

AL13	Bisoprolol 1.25mg	Tablets	1.25mg	om	Ongoing	β Andrenoceptor Blocker - Selective	High	High	0
AL13	Clopidogrel 75mg	Tablets	75mg	om	Ongoing	Antithrombotic - Antiplatelet	Low	Low	0
AL13	Indapamide 2.5mg	Tablets	1	od	Ongoing	Diuretics - Thiazides	High	High	0
AL13	Lactulose	Suspension	10ml	bd	Ongoing	Laxative - Osmotic	Low	Low	0
AL13	Lansoprazole	Capsules	15mg	od	Ongoing	Proton Pump Inhibitors	Low	Low	0
AL13	Ferrous Fumarate	Tablets	210mg	bd	Ongoing	Iron Supplement	Low	Low	0
AL14	Paracetamol	Tablets	500mg	4-6H	Prn	Analgesics - Non-Opioid	Low	Low	0
AL14	Sertraline	Tablets	50mg	om	Ongoing	Antidepressants - SSRI	High	High	1
AL14	Senna	Tablets	15mg	on	Ongoing	Laxative - Stimulant	Low	Low	0

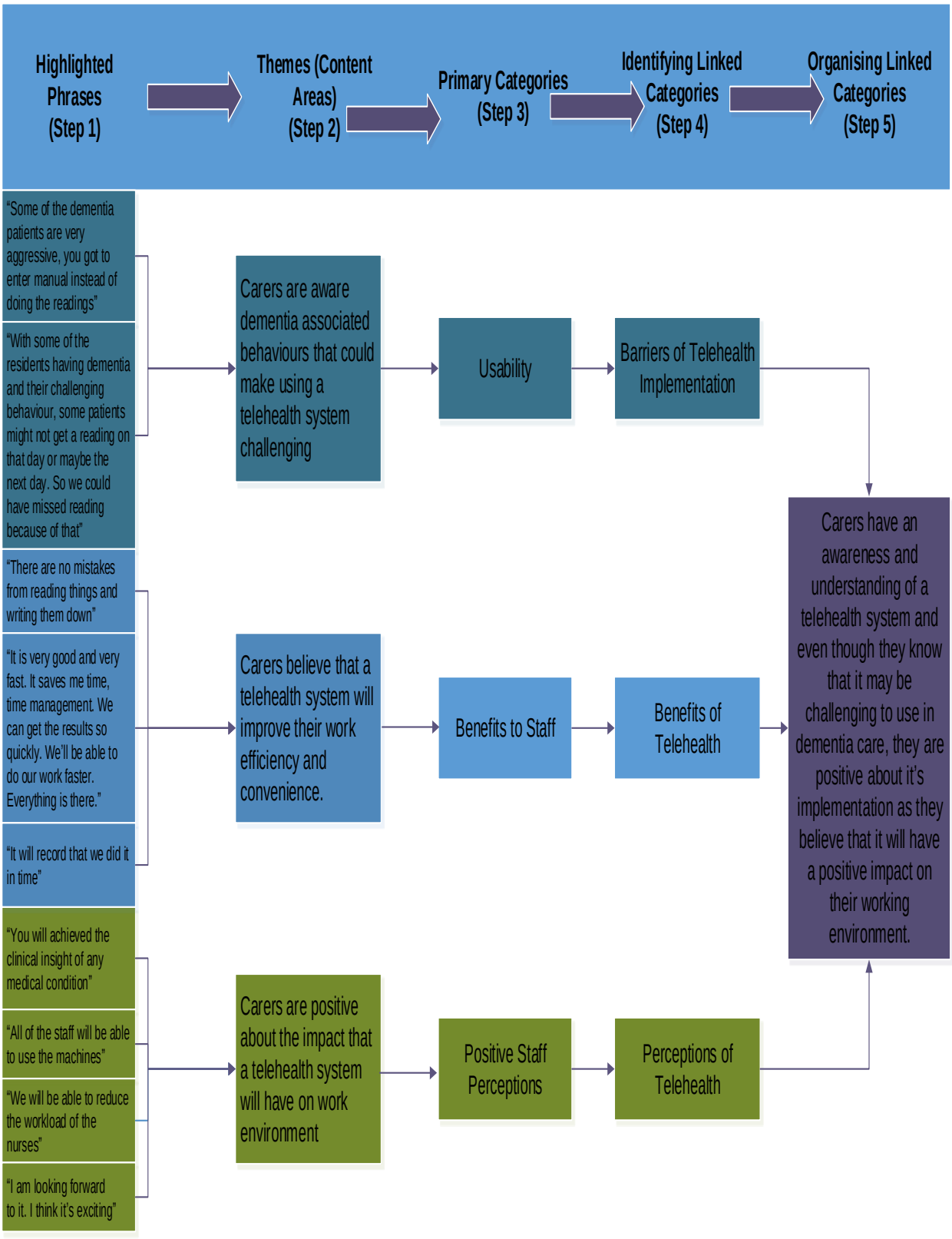
Appendix 8: Tunstall myClinic® Healthcare Professional SUS Ratings

Participant	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	SUS Score
DR1	3	2	4	3	3	3	3	2	3	2	60.0
DR2	3	1	4	2	4	2	5	2	5	2	80.0
DR3	3	3	4	4	4	3	3	2	3	2	57.5
DR4	1	4	3	4	1	4	1	2	4	3	32.5
DR5	3	4	4	2	2	4	4	3	3	2	52.5
DR6	3	4	4	3	4	3	2	2	3	2	55.0
RR1	4	1	4	1	4	4	4	1	5	1	82.5
RR2	3	2	4	2	4	4	3	3	3	2	60.0
RRM	3	2	4	1	3	4	3	2	3	2	62.5
AM	5	1	3	2	4	2	4	1	5	4	77.5
AN1	5	4	4	1	5	4	4	4	5	4	65.0
AN2	3	1	5	1	4	2	5	1	5	1	90.0
LAS1	3	2	4	1	2	3	4	2	4	4	62.5
LAS2	5	2	3	4	2	3	4	3	3	4	52.5
AC1	5	4	5	5	5	5	4	5	5	5	50.0
AC2	5	5	4	5	5	5	5	5	5	4	50.0
AC3	5	2	4	3	4	4	4	2	5	4	67.5
AC4	5	1	5	3	5	1	4	5	5	5	72.5
AC5	5	5	4	3	4	5	4	5	5	4	50.0
AC6	5	5	5	5	5	5	5	5	5	5	50.0
AC7	5	3	5	4	5	5	5	5	5	5	57.5
AC8	4	5	5	1	5	1	5	1	5	1	87.5
AC9	5	1	5	5	5	1	3	2	1	2	70.0
AC10	5	1	5	4	4	1	4	1	5	2	85.0
AC11	4	2	5	1	5	1	5	1	5	1	95.0
AC12	4	1	5	1	5	5	5	1	5	5	77.5
AC13	5	1	4	5	5	1	5	1	5	1	87.5
AC14	5	1	3	5	5	1	5	1	5	1	85.0

Table of SUS Rating from Participants*

*DR= Medical Doctor, RRN= Rapid Response Nurse, RRM= Rapid Response Management, AM= Albany Management, AN=Albany Nurse, LAS= London Ambulance Service Paramedic, AC= Albany Carer.

Appendix 9: Tunstall myClinic® Inductive Qualitative Content Analysis of Focus Groups



Appendix 10: Tunstall myClinic® Telehealth Codes and Themes Codebook

Theme	**Knowledge, Awareness and Understanding**	**Level of knowledge, awareness and understanding of TH**
Codes	Positive Experience	Previous positive TH experience
	Previous Knowledge, Awareness and Understanding	Previous knowledge, awareness and understanding of TH
	No change in Knowledge, Awareness and Understanding	No change in knowledge, awareness and understanding after implementation
	No previous knowledge	Healthcare professionals that have no awareness of TH
	Improved Knowledge, Awareness and Understanding	Improved knowledge, awareness and understanding of TH after implementation
Theme	**Barriers**	**Barriers reported to the implementation of TH**
Codes	Increased staff anxiety	Increased staff anxiety before the implementation of TH
	Inadequate Staff	Inadequate staff to support the implementation and use of TH
	Inadequate Training	Inadequate training as a barrier to TH Implementation
	Lack of GP support	Lack of GP support as a barrier to TH Implementation
	Lack of management support	Lack of management support as a barrier to TH Implementation
	Equipment Failure	Equipment Failure as a barrier to TH Implementation
	Poor Implementation	Poor Implementation as a barrier to TH Implementation
	Poor Recruitment	Poor Recruitment as a barrier to TH Implementation
	Poor Communication	Poor Communication as a barrier to TH Implementation
Theme	**Goals and Beliefs**	**Goals and beliefs before and after the implementation of TH**
Codes	Improved Clinical Effectiveness	Belief that TH improved clinical effectiveness
	Improved Clinical Efficiency	Belief that TH improved clinical efficiency
	Less workload than expected	Belief that TH has the potential to and did reduce workload
	Inadequate Clinical Effectiveness	Belief that TH provided inadequate clinical effectiveness
Theme	**Environmental Context and Resources**	**Environmental Context and Resources effect on the implementation of TH**
Codes	Previous delays in seeking medical advice on time	Historic delays in seeking medical advice for unwell residents
	Current high hospital admission rate	Historic high hospital admission rate
	Inadequate Clinical Alignment	Inadequate clinical alignment of TH in AL
	Equipment Suitability	Suitability of TH equipment in AL
Theme	**Professional Role Identity**	**TH effect on the role of healthcare professionals**
Codes	Loss of Professional Skill	Loss of Professional Skill due to the implementation of TH
	Improved HCP relationships	Improved HCP relationships due to the implementation of TH
	Improved Professional Role	Improved Professional Role due to the implementation of TH
Theme	**Emotion and Optimism**	**TH effect on the emotions and level of optimism of healthcare professionals**

Codes	Optimism	Level of optimism after TH implementation
	Future priority	Healthcare professionals believe that TH is a priority for a care home
	Not a future priority	Healthcare professionals believe that TH is not a priority for a care home
Theme	**Memory and Re-Enforcement**	**THS usage was memorable and re-enforced the use of TH**
Codes	Technology Adoption	Level of TH acceptance and adoption
	Ease of Use	Ease of use of the THS
Theme	**Behavioural Regulation**	**TH ability to change the behaviour of healthcare professionals**
Codes	Increased Monitoring	Increase in monitoring and care plans of residents
Theme	**Future Intentions**	**Future intentions for TH**
Codes	Future - Diseases	Use of TH for dementia and other diseases
	Future - Increased frequency of monitoring, training, feedback, awareness and understanding	Increased frequency of monitoring, training, feedback, awareness and understanding of TH in the future
	Future - Residential or Care Homes	Implementation of TH in care or residential homes in the future
	Future Clinical Alignment	Clinical alignment of TH in the future
	Future HCP collaboration	HCP collaboration during TH implementation in the future
	Future support	Increased support from management during TH implementation in the future

Appendix 11: Tunstall myClinic® Pre-Telehealth Thematic Networks

Quote	Initial Codes	Basic Themes	Organising Themes	Inductive or Deductive	Theory	Global Themes
"I think that it will be a good thing to start up because AL has high increase of residents going into hospital" ***(RRN2)***	Current high hospital admission rate	High Admission Rate	Environment	Inductive		Environmental Context and Resources
"Residents with dementia especially, they not as good as communicating certain things, if they in pain or if they got a temperature" **(P1)**	Equipment Suitability	Equipment Suitability for Dementia	Job Relevance	Deductive	Thompson et al. (1991) , Davis and Venkatesh (2000), Venkatesh and Bala (2008)	Environmental Context and Resources
"Most dementia residents, unless they have other chronic diseases, probably won't have much problems until they get to the end of life. So, I don't know what the value would be in dementia?" ***(D2)***	Equipment Suitability	Technology Environmental Suitability		Inductive		Environmental Context and Resources
"I am not sure if Telehealth is any particular advantage because I would hope that they would see a decline in the patient anyway." ***(D4)***	Equipment Suitability	Technology Environmental Suitability	Job Relevance	Deductive	Thompson et al. (1991) , Davis and Venkatesh (2000), Venkatesh and Bala (2008)	Environmental Context and Resources
"It is difficult to use the machine in dementia residents because of the confusion. I have tried, as soon as you apply the cuff, they just want to take it off" **(AN2)**	Equipment Suitability	Technology Environmental Suitability	Objective Usability	Deductive	Venkatesh (2000), Venkatesh and Bala (2008)	Environmental Context and Resources
"*How much money do you want to spend just for the reading? Value for money exercise* " **(D6)**	Equipment Suitability	Technology Environmental Suitability	Discomfort	Deductive	Parasuraman (2000), Panday (2015)	Environmental Context and Resources
"It wouldn't make any difference because if they ask me to do a home visit, my duty of care means I still have to do the home visit" **(D2)**	Inadequate Clinical Alignment	Not Supportive of Professional Role	Compatibility/Job-Fit	Deductive	Rogers (2003),Younghwa Lee et al. (2003), Holden and Karsh (2010)	Environmental Context and Resources
"I am not so sure that it will be particularly useful for infection because if they were normal before, it's not going to help you because nowthey are tachycardiac and hypertensive" **(D2)**	Inadequate Clinical Alignment	Not Supportive of Professional Role	Compatibility/Job-Fit	Deductive	Rogers (2003),Younghwa Lee et al. (2003), Holden and Karsh (2010)	Environmental Context and Resources
"*I can't base it just on numbers, I have to treat the patient and not the numbers* " **(D1)**	Inadequate Clinical Alignment	Poor System Design	Compatibility/Job-Fit	Deductive	Rogers (2003),Younghwa Lee et al. (2003), Holden and Karsh (2010)	Environmental Context and Resources
"*There is the obvious issue with the reliability of the testing* " **(D1)**	Inadequate Clinical Alignment	Poor System Design	Insecurity	Deductive	Parasuraman (2000), Panday (2015)	Environmental Context and Resources
"*We will be more responsive to people who are deteriorating and become acutely unwell* " **(D1)**	Improved Clinical Effectiveness	Improved Response	Perceived Output Quality	Deductive	Davis et al. (1992), Davis and Venkatesh (2000), Venkatesh and Bala (2008)	Goals and Beliefs
"*Some people are scared to ring 999 because they have been told that they are ringing too much so sometime there is a risk of not ringing the appropriate service when it is needed* " **(RRN1)**	Improved Clinical Efficiency	Improved Response Time	Perceived Output Quality	Deductive	Davis et al. (1992), Davis and Venkatesh (2000), Venkatesh and Bala (2008)	Goals and Beliefs
"*We had been penalised for a delay in seeking of medical advice. So, I think that telehealth will help me with this weakness* " **(AM)**	Improved Clinical Efficiency	Improved Response Time	Perceived Output Quality	Deductive	Davis et al. (1992), Davis and Venkatesh (2000), Venkatesh and Bala (2008)	Goals and Beliefs
"*We can get the results so quickly. We'll be able to do our work faster* " **(AC)**	Improved Clinical Efficiency	Improved Response Time	Perceived Output Quality	Deductive	Davis et al. (1992), Davis and Venkatesh (2000), Venkatesh and Bala (2008)	Goals and Beliefs
"*We can ring/phone the consultant with the data and ask for a possible diagnosis* " **(RRN1)**	Improved HCP relationships	Improved Response	Relative Advantage	Deductive	Davis et al. (1992), Davis and Venkatesh (2000), Venkatesh and Bala (2008)	Identification of Professional Role
"*Having the system, the more information you have, then it helps the clinician to make a decision about it* " **(RRN2)**	Improved Professional Role	Improved Clinical Response	Relative Advantage	Deductive	Davis et al. (1992), Davis and Venkatesh (2000), Venkatesh and Bala (2008)	Identification of Professional Role
"My hope is that it is doing part of my job, prevention of admission " **(RRN2)**	Improved Professional Role	Improved Response	Optimism	Deductive	Parasuraman (2000), Panday (2015)	Identification of Professional Role
"I guess it is more supportive for the staff and maybe a quicker response for residents" ***(P1)***	Improved Professional Role	Improved Response	Optimism	Deductive	Parasuraman (2000), Panday (2015)	Identification of Professional Role
"*We are de-skilling nurses* " **(RRN1)**	Loss of Professional Skill	Loss of Professional Skill	Insecurity	Deductive	Parasuraman (2000), Panday (2015)	Identification of Professional Role
"In the beginning I didn't have a clue regarding telehealth" ***(AN1)***	No previous knowledge	No Baseline Knowledge	Discomfort	Deductive	Parasuraman (2000), Panday (2015)	Knowledge, Awareness and Understanding
"It was okay. I mean the patient has to be motivated. It worked well " **(D2)**	Positive Experience	Previous Use	Perceived Behavioural Control	Deductive	Ajzen (1985), Taylor et al. (1995), Venkatesh (2000)	Knowledge, Awareness and Understanding
"*My past experience of telehealth has been very positive* " **(RRN2)**	Positive Experience	Previous Use	Perceived Behavioural Control	Deductive	Ajzen (1985), Taylor et al. (1995), Venkatesh (2000)	Knowledge, Awareness and Understanding
"*We have used it in my practice before for blood pressure monitoring* " **(D2)**	Positive Experience	Previous Use	Self-Efficacy	Deductive	Bandura (1977), Igbaria (1995), Yi et al. (2003), Younghwa et al. (2003)	Knowledge, Awareness and Understanding
"*Very little, they couldn't assess/recognise a sick patient, so they found that by looking at a patient on a camera it was very useful for you to know if they were sick or not* " **(D1)**	Previous Knowledge, Awareness and Understanding	Previous Use	Perceived Behavioural Control	Deductive	Ajzen (1985), Taylor et al. (1995), Venkatesh (2000)	Knowledge, Awareness and Understanding
"Remote monitoring and a remote way of being able to assess residents" **(D4)**	Previous Knowledge, Awareness and Understanding	Previous Use	Perceived Behavioural Control	Deductive	Ajzen (1985), Taylor et al. (1995), Venkatesh (2000)	Knowledge, Awareness and Understanding
"I think it all is going to depend on the work load of the day" **(AC)**	Inadequate Staff	Inadequate Staff	Facilitation	Deductive	Thompson et al. (1991), Venkatesh et al. (2003)	Perceived Barriers
"*I have to find time to do telehealth* " **(AN)**	Inadequate Staff	Inadequate Staff	Facilitation	Deductive	Thompson et al. (1991), Venkatesh et al. (2003)	Perceived Barriers
"*I think that one of the issues that always is a problem here is shortage of trained staff* " **(D4)**	Inadequate Training	Lack of Staff Training	Facilitation	Deductive	Thompson et al. (1991), Venkatesh et al. (2003)	Perceived Barriers
"I would be concerned about getting more calls because it may increase anxiety amongst staff actually" **(D4)**	Increased staff anxiety	Anxiety	Anchor	Deductive	Thompson et al. (1991), Venkatesh et al. (2003)	Perceived Barriers
"It will keep the GP's away from their residents" **(RRM)**	Increased staff anxiety	Anxiety	Anchor	Deductive	Igbaria et al. (1995), Venkatesh (2000), Younghwa et al. (2003), Venkatesh and Bala (2008)	Perceived Barriers
"*Management have to ensure that the right team are consistent in using the equipment* " **(P2)**	Lack of management support	Management Support	Facilitation	Deductive	Thompson et al. (1991), Venkatesh et al. (2003)	Perceived Barriers

Appendix 12: Tunstall myClinic® Pre-Telehealth Framework Frequency Matrix

Global Theme	Knowledge, Awareness and Understanding			Total
Initial Code	**No previous knowledge**	**Positive Experience**	**Previous Knowledge, Awareness and Understanding**	
Doctors	0	2	2	4
Albany Manager	0	0	0	0
Albany Nurse	1	0	0	1
Albany Carers	0	0	0	0
Rapid Response Nurse	0	1	0	1
Rapid Response Management	0	0	0	0
Paramedics	0	0	0	0
Total	**1**	**3**	**2**	**6**

Global Theme	Perceived Barriers				Total
Initial Code	**Inadequate Staff**	**Inadequate Training**	**Increased staff Anxiety**	**Lack of management Support**	
Doctors	0	1	1	0	2
Albany Manager	0	0	0	0	0
Albany Nurse	1	0	0	0	1
Albany Carers	1	0	0	0	1
Rapid Response Nurse	0	0	0	0	0
Rapid Response Management	0	0	1	0	1
Paramedics	0	0	0	1	1
Total	**2**	**1**	**2**	**1**	**6**

Global Theme	Goals and Beliefs		Total
Initial Code	**Improved Clinical Effectiveness**	**Improved Clinical Efficiency**	
Doctors	1	0	1
Albany Manager	0	1	1
Albany Nurse	0	0	0
Albany Carers	0	1	1
Rapid Response Nurse	0	1	1
Rapid Response Management	0	0	0
Paramedics	0	0	0
Total	1	3	**4**

Global Theme	Environmental Context and Resources			Total
Initial Code	**Current high hospital admission rate**	**Equipment Suitability**	**Inadequate Clinical Alignment**	
Doctors	0	3	4	7
Albany Manager	0	0	0	0
Albany Nurse	0	1	0	1
Albany Carers	0	0	0	0
Rapid Response Nurse	1	0	0	1
Rapid Response Management	0	0	0	0
Paramedics	0	1	0	1
Total	**1**	**5**	**4**	**10**

Global Theme	Identification of Professional Role			Total
Initial Code	**Improved HCP relationships**	**Improved Professional Role**	**Loss of Professional Skill**	
Doctors	0	0	0	0
Albany Manager	0	0	0	0
Albany Nurse	0	0	0	0
Albany Carers	0	0	0	0
Rapid Response Nurse	1	2	1	4
Rapid Response Management	0	0	0	0
Paramedics	0	1	0	1
Total	**1**	**3**	**1**	**5**

Tunstall myClinic® Post-Telehealth Framework Frequency Matrix

Global Theme	Knowledge, Awareness and Understanding		Total
Initial Code	No change in knowledge, awareness and understanding	Improved Knowledge, Awareness and	
Doctors	1	1	**2**
Albany Manager	0	1	**1**
Albany Nurse	0	1	**1**
Albany Carers	1	4	**5**
Rapid Response Nurse	2	1	**3**
Rapid Response Management	0	0	**0**
Paramedic	0	2	**2**
Head of Community Nursing	0	0	**0**
Total	**4**	**10**	**14**

Global Theme	Barriers								Total
Initial Code	Inadequate Staff	Inadequate Training	Lack of GP support	Lack of management	Equipment Failure	Poor Implementation	Poor Recruitment	Poor Communication	
Doctors	0	3	1	0	1	3	1	3	**12**
Albany Manager	1	1	0	0	1	0	0	0	**3**
Albany Nurse	2	0	0	0	1	0	1	0	**4**
Albany Carers	2	2	0	0	0	0	0	1	**5**
Rapid Response Nurse	0	3	1	1	2	2	3	3	**15**
Rapid Response Management	2	1	0	0	2	9	1	2	**17**
Paramedic	1	0	0	0	1	2	0	1	**5**
Head of Community Nursing	1	0	1	1	0	1	0	0	**4**
Total	**9**	**10**	**3**	**2**	**8**	**17**	**6**	**10**	**65**

Global Theme	Goals and Beliefs				Total
Initial Code	Improved Clinical Effectiveness	Improved Clinical Efficiency	Less workload than expected	Inadequate Clinical Effectiveness	
Doctors	1	0	1	10	**12**
Albany Manager	1	0	0	0	**1**
Albany Nurse	8	4	0	0	**12**
Albany Carers	4	19	0	0	**23**
Rapid Response Nurse	2	0	2	3	**7**
Rapid Response Management	0	0	0	1	**1**
Paramedic	0	0	0	2	**2**
Head of Community Nursing	0	0	0	1	**1**
Total	**16**	**23**	**3**	**17**	**59**

Global Theme	Environmental Context and		Total
Initial Code	Inadequate Clinical	Equipment Suitability	
Doctors	8	2	**10**
Albany Manager	0	1	**1**
Albany Nurse	1	0	**1**
Albany Carers	0	0	**0**
Rapid Response Nurse	4	1	**5**
Rapid Response Management	5	0	**5**
Paramedic	0	0	**0**
Head of Community Nursing	3	1	**4**
Total	**21**	**5**	**26**

Global Theme	Professional Role Identity			Total
Initial Code	Loss of Professional	Improved HCP relationships	Improved Professional Role	
Doctors	0	0	1	**1**
Albany Manager	0	3	0	**3**
Albany Nurse	0	1	3	**4**
Albany Carers	0	0	2	**2**
Rapid Response Nurse	0	2	6	**8**
Rapid Response Management	0	1	1	**2**
Paramedic	1	0	1	**2**
Head of Community Nursing	0	0	1	**1**
Total	**1**	**7**	**15**	**23**

Global Theme	Emotion and Optimism			Total
Initial Code	Optimism	Future priority	Not a future priority	
Doctors	0	3	7	**10**
Albany Manager	0	1	0	**1**
Albany Nurse	0	1	0	**1**
Albany Carers	6	21	0	**27**
Rapid Response Nurse	0	0	2	**2**
Rapid Response Management	0	0	0	**0**
Paramedic	0	2	0	**2**
Head of Community Nursing	0	0	1	**1**
Total	**6**	**28**	**10**	**44**

Global Theme	Memory and Re-Inforcement		Total
Initial Code	Technology	Ease of Use	
Doctors	0	0	**0**
Albany Manager	0	1	**1**
Albany Nurse	1	2	**3**
Albany Carers	0	6	**6**
Rapid Response Nurse	0	0	**0**
Rapid Response Management	0	1	**1**
Paramedic	0	0	**0**
Head of Community Nursing	0	0	**0**
Total	**1**	**10**	**11**

Global Theme	Behavioural Regulation
Initial Code	Increased
Doctors	0
Albany Manager	2
Albany Nurse	2
Albany Carers	0
Rapid Response Nurse	3
Rapid Response Management	0
Paramedic	1
Head of Community Nursing	1
Total	**9**

Global Theme	Future Intentions						Total
Initial Code	Future - Diseases	Future - Increased frequency of monitoring, training, feedback, awareness and	Future - Residential or Care Homes	Future Clinical Alignment	Future HCP collaboration	Future support	
Doctors	2	4	0	9	2	2	**19**
Albany Manager	1	0	0	0	0	0	**1**
Albany Nurse	1	0	0	2	0	0	**3**
Albany Carers	7	2	0	1	0	0	**10**
Rapid Response Nurse	2	1	4	3	1	2	**13**
Rapid Response Management	0	0	3	2	2	2	**9**
Paramedic	0	2	0	1	0	1	**4**
Head of Community Nursing	1	0	1	4	1	1	**8**
Total	**14**	**9**	**8**	**22**	**6**	**8**	**67**

Appendix 13: Tunstall myClinic® Post-Telehealth Thematic Network

Quote	Initial Codes	Basic Themes	Organising Themes	Inductive or Deductive	Theory	Global Themes
"I think that it has potential, but it was flawed in some areas e.g. getting alerts through and the equipment not working at the end was not great particularly when you get an alert and someone's saturation levels were 66%. Then you think if they are 66% then we have a problem here and then they should they be sitting in a home instead of a hospital? If they were 66% we would have to go out" ***(RRM)***	Equipment Failure	Equipment Suitability	Design Chasm, Assessment Chasm, Technology Attributes, Facilitation	Deductive	Lorenzi (2008), Rogers (2003), Thompson (1991)	Barriers
"In some cases, we ring up and their blood pressure is always a bit low. I would perhaps ensure that the equipment is robust and being calibrated and having parameters for individual residents" ***(D1)***	Equipment Failure	Equipment Suitability	Design Chasm, Assessment Chasm, Technology Attributes, Facilitation	Deductive	Lorenzi (2008), Rogers (2003), Thompson (1991)	Barriers
"It seemed a bit hit and miss at times e.g. machinery did not work" ***(P1)***	Equipment Failure	Equipment Suitability	Design Chasm, Assessment Chasm, Technology Attributes, Facilitation	Deductive	Lorenzi (2008), Rogers (2003), Thompson (1991)	Barriers

"My other concern is that when I used the machine to take the readings, it took too long to take the readings" ***(AN1)***	Equipment Failure	Equipment Suitability	Design Chasm, Performance, Technology Attributes, PBC, Perceived Enjoyment	Deductive	Lorenzi (2008), Venkatesh (2003), Rogers (2003), Taylor et al. (1995), Igbaria (1995), Venkatesh (2000)	Barriers
"Making sure that the system wasn't faulty" ***(RRN1)***	Equipment Failure	Equipment Suitability	Facilitation, Assessment and Management Chasm, Output Quailty	Deductive	Thompson (1991), Lorenzi (2008), Davis (1992), Davis and Venkatesh (2000)	Barriers
"What we found at the end was that they were having to do a set of observations twice because the equipment was not working" ***(RRM)***	Equipment Failure	Equipment Suitability	Objective Usability, Output Quality, Technology Attributes, System Quality, Effort Expectancy, PBC, Observability and Trialability	Deductive	Venkatesh (2000), Davis (1992), Davis and Venkatesh (2000), Rogers (2003), Lee et al. (2003), Taylor et al. (1995), Venkatesh et al. (2003)	Barriers
"They had issues with the equipment. They broke one of them to be perfectly honest. We kept getting a phone call to say that they had not docked it properly" ***(RRN1)***	Equipment Failure	Equipment Suitability	Technology Attributes, System Quality, Performance	Deductive	Rogers (2003), Davis and Venkatesh (2000), Lee et al. (2003), Venkatesh (2003)	Barriers
"I didn't feel that we had enough system support initially. Thereafter they became a bit proactive" ***(AM)***	Equipment Failure	Equipment Suitability	Facilitating Conditions	Deductive	Thompson (1991)	Barriers

"This care home has a high turnover of staff; I don't think that that will ever go away" ***(P1)***	Inadequate Staff	High turnover of staff	Facilitating Conditions	Deductive	Thompson (1991)	Barriers
"On the day that TH readings need to be taken, especially on the dementia floor, an extra staff member is required to assist as it is a busy floor and we have to protect the residents that walk in the corridor" ***(AC11)***	Inadequate Staff	Inadequate staff levels	Organisation and Management Chasm, Facilitation	Deductive	Lorenzi (2008), Thompson (1991)	Barriers
"We could have used a bit of extra assistance sometimes" ***(AN2)***	Inadequate Staff	Inadequate staff levels	Organisation and Management Chasm, Facilitation	Deductive	Lorenzi (2008), Thompson (1991)	Barriers
"A lot of the alerts were coming through after 2pm and we get busier in the afternoon. It wasn't always easy to drop everything when a TH referral came in" ***(RRM)***	Inadequate Staff	Inadequate staff levels	Organisation and Management Chasm, Facilitation	Deductive	Lorenzi (2008), Thompson (1991)	Barriers
"The additional work is that sometimes it came through quite late and obviously we get quite busy towards the end of the day. That was a little bit tedious and we have said doesn't work for us" ***(RRM)***	Inadequate Staff	Inadequate staff levels	Organisation and Management Chasm, Facilitation, Compatibility/Job-Fit	Deductive	Lorenzi (2008), Thompson (1991), Holden and Karsh (2010), Rogers (2003), Lee (2003)	Barriers

"Sometimes with the workload, staff can't take the readings within the 10am to 2pm slot including their lunch time" ***(AM)***	Inadequate Staff	Inadequate staff levels	Organisation and Management Chasm, Facilitation, Compatibility/Job-Fit	Deductive	Lorenzi (2008), Thompson (1991), Holden and Karsh (2010), Rogers (2003), Lee (2003)	Barriers
*"My only concern is that it is more work for us "****(AC7)***	Inadequate Staff	Inadequate staff levels	Organisation and Management Chasm, Facilitation, Compatibility/Job-Fit	Deductive	Lorenzi (2008), Thompson (1991), Holden and Karsh (2010), Rogers (2003), Lee (2003)	Barriers
"Sometimes you are the only one on the floor and you are so busy, but you still have to do TH within the time frame" ***(AN2)***	Inadequate Staff	Inadequate staff levels	Organisation and Management Chasm, Facilitation, Compatibility/Job-Fit	Deductive	Lorenzi (2008), Thompson (1991), Holden and Karsh (2010), Rogers (2003), Lee (2003)	Barriers
"I have been given this project on top of my usual day work but acknowledging that I have no additional time to do it and no additional funding has been granted to do that" ***(CN)***	Inadequate Staff	Inadequate staff levels	Organisation and Management Chasm, Facilitation, Compatibility/Job-Fit, Voluntariness	Deductive	Lorenzi (2008), Thompson (1991), Holden and Karsh (2010), Rogers (2003), Lee (2003)	Barriers
"For my team, the training was fine. If you include too much information, it becomes confusing for them" ***(AM)***	Inadequate Training	Training Intensity	User Training, Facilitation	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003)	Barriers

"I don't think that I have had any specific training and I have not had a follow up or ongoing training. In-between there has been a large void" ***(D6)***	Inadequate Training	Training Intensity	User Training, Facilitation, Assessment Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers
"I thought that it was management's responsibility to ensure that everyone is involved to take part in this training. We should have a refresher training day for the staff who missed out" ***(AC11)***	Inadequate Training	Training Intensity	User Training, Facilitation, Management Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers
"AL has a high staff turnover and new staff need to be trained or the machine will not be used" ***(D6)***	Inadequate Training	Training Intensity	User Training, Facilitation, Management Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers
*"The initial training provided was not adequate" (****RRN2)***	Inadequate Training	Training Intensity	User Training, Facilitation, Management Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers
"I don't think that I have had any specific training and I have not had a follow up or ongoing training" ***(D6)***	Inadequate Training	Training Intensity	User Training, Facilitation, Management Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers

"They have got a lot of staff and I don't know if everybody had got the same training" ***(RRM)***	Inadequate Training	Training Intensity	User Training, Facilitation, Management Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers
"I am not sure how many people had the training. The training needs to be spread more" ***(RRN2)***	Inadequate Training	Training Intensity	User Training, Facilitation, Management Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers
"If only one person knows how to use the system and if it is that person's day off, then there will be trouble" ***(AC11)***	Inadequate Training	Training Intensity	User Training, Facilitation, Management Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers
"When it first started, it would have been best to ensure that the staff knew what they were doing" ***(RRN1)***	Inadequate Training	Training Intensity	User Training, Facilitation, Management Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers
"It became an AL project rather than a GP-AL project" ***(D6)***	Lack of GP support	GP Integration	Facilitation, Mangement and Assessment Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers

"There is also the challenge of getting the GP's on-board. If we get some alerts, what are they going to do about it? Are they interested?" ***(CN)***	Lack of GP support	GP Integration	Facilitation, Mangement and Assessment Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers
"Where do you draw the line? We left that with the GP to decide when to act on it, but nothing happened" ***(RRN2)***	Lack of GP support	GP Integration	Facilitation, Mangement and Assessment Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers
"There have been a few times that I have turned up and management have not been able to meet me" ***(CN)***	Lack of management support	Management Support Failure	Facilitation, Mangement and Assessment Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers
"The person that was leading on it retired and there was a limbo land" ***(RRN2)***	Lack of management support	Management Support Failure	Facilitation, Mangement and Assessment Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers
"Some of the people don't know what it is about. The night nurses don't know anything" ***(RRN2)***	Poor communication	Communication Strategy	Facilitation, Assessment and Management Chasm	Deductive	Thompson (1991), Igbaria (1995), Davis and Venkatesh (1996), Lee (2003), Lorenzi (2008)	Barriers

"I was concerned that they wouldn't know what it was and didn't know why we were doing it for residents with long-term conditions" ***(RRN2)***	Poor communication	Communication Strategy	Implementation process, Job Relevance, Assessment Chasm, Long-term consequences	Deductive	Swanson (1988), Lucas (1990), Mathieson (1991), Davis and Venkatesh (1996), Lorenzi (2008), Thompson (1991), Chau (1996)	Barriers
"You get told that you are obviously getting it but you are not picking them up and people were disbelieving the fact that we were not getting them until it was discovered that we were not getting them. That is disappointing for a pilot" ***(RRM)***	Poor Communication	Communication Strategy	Management Chasm, Assessment Chasm	Deductive	Lorenzi (2008)	Barriers
"The THS has not been discussed in meeting to say that this system is working brilliantly" ***(AC1)***	Poor communication	Communication Strategy	Management Chasm, Assessment Chasm	Deductive	Lorenzi (2008)	Barriers
"I think most of the time that I have been in the dark really" ***(D3)***	Poor communication	Communication Strategy	Management Chasm, Assessment Chasm	Deductive	Lorenzi (2008)	Barriers
"AL has not fed back to us if it has prevented the residents from going into hospital" ***(RRN2)***	Poor communication	Communication Strategy	Management Chasm, Assessment Chasm	Deductive	Lorenzi (2008)	Barriers

"The team has not liaised with me in regard to use of TH. There was no follow up to update us on the challenges experienced in implementation" ***(D6)***	Poor communication	Communication Strategy	Management Chasm, Assessment Chasm	Deductive	Lorenzi (2008)	Barriers
"I am not sure if the residents understood if they were a part of it" ***(RRM)***	Poor communication	Communication Strategy	Management Chasm, Assessment Chasm	Deductive	Lorenzi (2008)	Barriers
"Once or twice I have received information through the nurses but that's about it" ***(D5)***	Poor communication	Communication Strategy	Management Chasm, Assessment Chasm	Deductive	Lorenzi (2008)	Barriers
"Everyone who has invested time needs to be reviewed as the communication has been quite poor" ***(P1)***	Poor communication	Communication Strategy	Management Chasm, Assessment Chasm	Deductive	Lorenzi (2008)	Barriers
"We didn't really know what we were doing, we were never able to access the TH. We didn't know why the referrals were not coming through initially. It was just a bit disjointed for me. I don't think that we had a full understanding of the way in which it was working. Who was setting parameters? Who looks at them? Who was reviewing these residents within three months to say that they are still	Poor Implementation	Implementation Methodology	Design Chasm, Assessment Chasm, Technology Attributes, Facilitation, Self-Efficacy, User design participation	Deductive	Lorenzi (2008), Rogers (2003), Thompson (1991), Bandura (1977), Igbaria et al. (1995), Yi et al. (2003), Lee et al. (2003), Davis and Venkatesh (1996)	Barriers

suitable to be on the pilot?" ***(RRM)***						
"Because they were not docking it properly, we were then not getting the readings until the following day" ***(RRN1)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers

"We have been to AL to facilitate understanding of the importance of handover and our expectations to be met but TH didn't come into that discussion since we implemented TH at AL" ***(P2)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers
"I have not heard the crew speak of it either, so I don't know if when an ambulance is requested whether the crews are being updated with the information from the THS" ***(P1)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers

"I have not had any feedback where a nurse at AL had used TH and contacted me because of some finding that they had discovered and needed my expertise" ***(D6)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers
"That didn't happen with TH. I have never had anyone from Rapid Response contact me, even if they did, it was not enough to remember" ***(D6)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers

"Having been told a week before that you are doing it, when you didn't know what was happening. I think that it was insulting to the staff" ***(RRM)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers
It was literally: "Here's an e-mail address, here's your code, and off you go!" ***(RRM)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers

The reason it has failed is because it was just thrown in: "Here is the machine and the training, use it! If we could all do that, we could all be geniuses" ***(D6)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers
"My question to whoever set the parameters is what is low that we should be getting worried?" ***(RRM)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers

"A lot of these residents, I'm not sure if the parameters were set correctly" ***(RRM)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers
"That was the problem that we had so when it was initially set up, we were not given access to the parameters" ***(RRN1)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers

"He just doesn't function particularly well in the morning; he gets agitated and obviously that caused his blood pressure to rise. They repeated his blood pressure reading in the afternoon and it had settled down" ***(RRM)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers
We need to be more flexible about the times that the readings are taken" ***(CN)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers

I think that it is difficult because the residents were on the dementia floor. A lot of their readings were when they were agitated, and it was not the right time of the day and it was difficult and that is difficult to manage" ***(RRM)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers
"I think it was flawed. The implementation for me was not good because we were not a part of it. It is very difficult for people to understand the whole concept when they have not been a part of it" ***(RRM)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers

"I think a bit more pre-planning for me as a manager would have been better because we didn't have enough time to implement it as there was staff away when we were doing it" ***(RRM)***	Poor Implementation	Poor system implementation	User Training, Facilitation, Management Chasm, Self-Efficacy, PBC, Implementation Process	Deductive	Igbaria et al. (1995), Davis and Venkatesh (1996), Agarwal et al. (1999), Lee (2003), Thompson (1991), Lorenzi (2008), Bandura (1977), Yi et al. (2003), Lee et al. (2003), Taylor et al. (1995), Swanson (1988), Lucas (1990), Mathieson (1991)	Barriers
"It's about finding the right people, so I won't have thought the residents chosen were that appropriate. It might have been nice for staff to actually choose the residents. Residents need to be reviewed. We didn't know who was reviewing the residents" ***(RRM)***	Poor recruitment	Poor participant recruitment	Design Chasm, User design participation, Trialability	Deductive	Lorenzi (2008), Davis and Venkatesh (1996), Rogers (2003)	Barriers
"We need to choose the right patient in the project. It would a more productive study if the residents are able and have no memory issues" ***(RRN2)***	Poor Recruitment	Poor participant recruitment	Design Chasm, User design participation, Trialability	Deductive	Lorenzi (2008), Davis and Venkatesh (1996), Rogers (2003)	Barriers

"I think that we should use TH for dementia residents, but we need to select the residents that are more co-operative. If you ask the nurses, they will ask you tell you who is not co-operative, and it will be blank for their monitoring. Non-cooperative residents also will take more nursing time to take vital observations. This will be helpful for nurses and residents" ***(RRN1)***	Poor recruitment	Poor participant recruitment	Design Chasm, User design participation, Trialability	Deductive	Lorenzi (2008), Davis and Venkatesh (1996), Rogers (2003)	Barriers
"We have seen resistance to using TH equipment on our Rapid Response sheets where it states that patient refused" ***(D1)***	Poor Recruitment	Poor participant recruitment	Design Chasm, User design participation, Trialability	Deductive	Lorenzi (2008), Davis and Venkatesh (1996), Rogers (2003)	Barriers
"They will be moving their hands, so we won't get accurate readings" ***(AN1)***	Poor Recruitment	Poor participant recruitment	Design Chasm, User design participation, Trialability	Deductive	Lorenzi (2008), Davis and Venkatesh (1996), Rogers (2003)	Barriers
"If it comes from them and they think that they need that, then they probably will use the THS" ***(RRN2)***	Poor Recruitment	Poor participant recruitment	Design Chasm, User design participation, Trialability	Deductive	Lorenzi (2008), Davis and Venkatesh (1996), Rogers (2003)	Barriers

"If the staff can tell me the results for observations done five days a week and what the normal observations of a resident is because the resident can't talk to you, it would be beneficial to residents" ***(P2)***	Increased Monitoring	Improved Monitoring Behaviour	Output Quality, Results Demonstrability, Performance, Long-term Consequences, Relative Advantage, Internalisation	Deductive	Davis (1992), Davis and Venkatesh (2000), Rogers (2003), Venkatesh and Bala (2008), Venkatesh (2003), Thompson (1991), Chau (1996), Kelman (1958), French and Raven (1959), Taylor et al. (1995), Malhotra et al. (1999)	Behavioural Regulation
"Once the THS puts pressure on the staff that the reading has to be taken if not daily, at least weekly. If we don't have the THS, the readings will only be taken when needed. When an incident happens, they will start checking the frequency of the readings. If the readings are only taken monthly, this is not acceptable" ***(AM)***	Increased Monitoring	Improved Monitoring Behaviour	Output Quality, Results Demonstrability, Performance, Long-term Consequences, Relative Advantage, Internalisation	Deductive	Davis (1992), Davis and Venkatesh (2000), Rogers (2003), Venkatesh and Bala (2008), Venkatesh (2003), Thompson (1991), Chau (1996), Kelman (1958), French and Raven (1959), Taylor et al. (1995), Malhotra et al. (1999)	Behavioural Regulation

"TH has highlighted the need to monitor vital signs weekly as a routine and the need to act on it" ***(RRN2)***	Increased Monitoring	Improved Monitoring Behaviour	Output Quality, Results Demonstrability, Performance, Long-term Consequences, Relative Advantage, Internalisation	Deductive	Davis (1992), Davis and Venkatesh (2000), Rogers (2003), Venkatesh and Bala (2008), Venkatesh (2003), Thompson (1991), Chau (1996), Kelman (1958), French and Raven (1959), Taylor et al. (1995), Malhotra et al. (1999)	Behavioural Regulation
"The technology is a good way to monitor the residents weekly" ***(AN1)***	Increased Monitoring	Improved Monitoring Behaviour	Output Quality, Results Demonstrability, Performance, Long-term Consequences, Relative Advantage, Internalisation	Deductive	Davis (1992), Davis and Venkatesh (2000), Rogers (2003), Venkatesh and Bala (2008), Venkatesh (2003), Thompson (1991), Chau (1996), Kelman (1958), French and Raven (1959), Taylor et al. (1995), Malhotra et al. (1999)	Behavioural Regulation

"We didn't have the vital signs available before. Taking vital signs is part of their routine now but once they have finished the pilot, I am sure that that culture of monitoring vital signs will be there" ***(RRN2)***	Increased Monitoring	Improved Monitoring Behaviour	Output Quality, Results Demonstrability, Performance, Long-term Consequences, Relative Advantage, Internalisation	Deductive	Davis (1992), Davis and Venkatesh (2000), Rogers (2003), Venkatesh and Bala (2008), Venkatesh (2003), Thompson (1991), Chau (1996), Kelman (1958), French and Raven (1959), Taylor et al. (1995), Malhotra et al. (1999)	Behavioural Regulation
"I would like to think that you be getting anyways being in a nursing home that you would be getting nursing care anyways which would include doing observations and checking their weight if necessary and their blood pressure if they are known to be hypertensive or hypotensive" ***(RRN1)***	Increased Monitoring	Improved Monitoring Behaviour	Output Quality, Results Demonstrability, Performance, Long-term Consequences, Relative Advantage, Internalisation	Deductive	Davis (1992), Davis and Venkatesh (2000), Rogers (2003), Venkatesh and Bala (2008), Venkatesh (2003), Thompson (1991), Chau (1996), Kelman (1958), French and Raven (1959), Taylor et al. (1995), Malhotra et al. (1999)	Behavioural Regulation

"I would want the nurses to do regular observations with their own questions trees with their own format. They will take ownership of that" ***(CN)***	Increased Monitoring	Improved Monitoring Behaviour	Output Quality, Results Demonstrability, Performance, Long-term Consequences, Relative Advantage, Internalisation	Deductive	Davis (1992), Davis and Venkatesh (2000), Rogers (2003), Venkatesh and Bala (2008), Venkatesh (2003), Thompson (1991), Chau (1996), Kelman (1958), French and Raven (1959), Taylor et al. (1995), Malhotra et al. (1999)	Behavioural Regulation
"The THS makes you take the blood pressure every week and should therefore be a priority for a care home. If we do not use the THS, they we will not have contact with external support services" ***(AM)***	Increased Monitoring	Improved Monitoring Behaviour	Output Quality, Results Demonstrability, Performance, Long-term Consequences, Relative Advantage, Internalisation	Deductive	Davis (1992), Davis and Venkatesh (2000), Rogers (2003), Venkatesh and Bala (2008), Venkatesh (2003), Thompson (1991), Chau (1996), Kelman (1958), French and Raven (1959), Taylor et al. (1995), Malhotra et al. (1999)	Behavioural Regulation

"I think that TH is a priority to AL because it ensures regular monitoring of the healthcare of residents and a proper regular record of resident's health status" ***(AN1)***	Increased Monitoring	Improved Monitoring Behaviour	Output Quality, Results Demonstrability, Performance, Long-term Consequences, Relative Advantage, Internalisation	Deductive	Davis (1992), Davis and Venkatesh (2000), Rogers (2003), Venkatesh and Bala (2008), Venkatesh (2003), Thompson (1991), Chau (1996), Kelman (1958), French and Raven (1959), Taylor et al. (1995), Malhotra et al. (1999)	Behavioural Regulation
"TH should be a priority for a nursing care home" ***(AC1, AC2, AC3, AC4, AC5, AC6, AC7, AC8, AC9, AC10, AC11 and AC12)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"I think that the THS is very important for a care home" ***(AC13)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism

"I also think that the THS is very important for a care home" ***(AC14)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"TH should be a priority for a care home if it is utilised in the way that it should be used" ***(P2a)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"I would like to continue to use it at AL" ***(AM)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism

"We would like to continue to use it at AL" ***(AC7, AC8, AC9, AC10, AC11, AC12)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"I am very confident that the TH was successful, and we should continue and use it on all floors" ***(AC13)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"I think that it would benefit AL because there are areas of improvement at AL which are needed" ***(D4)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism

"I think that the system was good, and I think that it would be helpful if it continues" ***(D5)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"TH is getting a positive result for the residents so in the future we could continue with this work. I would suggest that we continue this work in the future" ***(AN1)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"I hope that TH will continue at AL and it is beneficial" ***(P1)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism

"Hopefully TH will continue at AL" ***(P2)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"The THS can be useful under certain circumstances but think that it is an aid" ***(D3)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"The THS is a definite priority for a residential home but for a good nursing home where nurses are monitoring the residents, I am not sure how important it will be" ***(D5)***	Future priority	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism

"I think TH would be a low priority for nursing homes" ***(D1)***	Not a future priority	TH Pessimism	Pessimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"I do not think that TH should be a priority for a care home because staff monitor the residents and especially one that does not use a lot of locums, they actually can tell when a resident is deteriorating" ***(D2)***	Not a future priority	TH Pessimism	Pessimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"I don't want TH; I can manage without TH" ***(D6)***	Not a future priority	TH Pessimism	Pessimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism

"I don't think that TH should be a priority for a nursing care home because we should be trained enough to interpret our own results" ***(RRN1)***	Not a future priority	TH Pessimism	Pessimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"I think the TH service will unlikely continue in the current economic climate unless they think that it will save them money in the long run. I am not sure how successful it has been, so I am not sure if it should continue or not" ***(D3)***	Not a future priority	TH Pessimism	Pessimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"I don't think AL should continuing using TH in that form. My personal view is that it has not given any added benefit" ***(CN)***	Not a future priority	TH Pessimism	Pessimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism

"As the THS is, I personally don't think that it has been very successful. I haven't seen a huge impact from it. That is not to say that it doesn't have a role" ***(D1)***	Not a future priority	TH Pessimism	Pessimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"I don't think the THS was successful at AL. I don't want TH; I can manage without TH" ***(D6)***	Not a future priority	TH Pessimism	Pessimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"I don't think in AL it necessarily needs to continue but if you are going to do something like this then we need to be on board with this. I don't think that AL needs to carry on. I would not like TH to continue at AL. AL doesn't need to have this anymore" ***(RRN1)***	Not a future priority	TH Pessimism	Pessimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism

"On one occasion I asked AL about the TH and they told me that they found it cumbersome. There was one resident which is very difficult to control which was suddenly hypoglycaemic. You are not going to prevent that. TH would have not prevented that. I don't want TH; I can manage without TH" ***(D6)***	Not a future priority	TH Pessimism	Pessimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism
"We feel positive about the system" ***(AC1, AC2, AC3, AC4, AC5, AC6)***	Optimism	TH Optimism	Optimism, Beliefs	Deductive	Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015)	Emotion and Optimism

"The questions can't be applied because the health status of the residents' changes from the time that you are taking the reading to later. The response to the questions asked in the morning will be different to the responses in the afternoon for dementia residents" ***(AM)***	Equipment Suitability	Environment-Equipment Suitability	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"The residents are elderly and suffer from dementia so there may be resistance to check a blood pressure, examination or give medication" ***(D6)***	Equipment Suitability	Environment-Equipment Suitability	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

*"My only concern is the way TH works here, that is, for the ability for the GP to come out on a regular basis. That is my one concern that is: is that feasible" (**D4)***	Equipment Suitability	Environment-Equipment Suitability	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"You would hope that a care home should be weighing their residents monthly as part of record keeping. This would pick up a lot of the weight problems, certainly with dementia and in heart failure, you would do that more frequently. If care homes are giving insulin, they are monitoring blood insulin levels anyway" ***(CN)***	Equipment Suitability	Environment-Equipment Suitability	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"The equipment that we are using need to be updated. There needs to be consistent monthly quality control checks on the machine. The equipment needs to be fit for purpose and ensure that everyone knows how to use it. The probe covers for the thermometer needs to be available" ***(RRN2)***	Equipment Suitability	Environment-Equipment Suitability	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"There was no plan for any of these residents" ***(RRM)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"Are we going link TH with the clinical management plan or a patient specific protocol?" ***(CN)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"We are here, why do we need to use another interface, what is the purpose?" ***(CN)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"Why are we doing this in this format?" ***(CN)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"I don't think that I could have foreseen these issues but knowing how it fits in with additional services" ***(D1)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"If somebody has dementia, they are variable every single day" ***(RRN1)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"The residents were difficult as it is an elderly dementia floor and could be risky or uncooperative" ***(AN1)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"The issue that I have sometimes is that we measure observations for the sake of saying that we have done it and that we have satisfied the regulatory aspect and that we are looking after our residents but actually it doesn't help the resident because we might be exposing them to further in appropriate treatments and investigations" ***(D1)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"We need to be clear who the patient cohort is and what the benefit for doing it is? For someone who doesn't have capacity as in dementia, you have to be clear that what you are doing is in the best interest" ***(D1)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"I am not so sure what the reliability of random observations is going to be" ***(D1)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"A once off observation once a week is very difficult to interpret without having any further information about the resident or the trend of those observations" ***(D1)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"I can see the value of TH in residential care homes and private homes but not at AL as they have good nurses" ***(RRM)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"The observations in themselves are not hugely reliable marker of someone's decline" ***(D1)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"It should be clearer how the response will be actioned and having the support of the GP during the study and have a clearly defined role of the GP involvement e.g. a telephone conversation and guidance on the management" ***(RRN2)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"Rapid Response needs clear guidelines of what functions are expected to be conducted during a response e.g. a phone call or a visit. The GP needs to be available during pre-allocated times e.g. an hour slot once a week to review all the data and formulate a picture of what's going on" ***(RRN2)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"They had the parameters there which is fine but perhaps we could have had a bit more access. I understand that there was a computer system, but we were very unsure as to how to get on to it. Even if the parameters had been sent through to us, it is something that we can have up so that if something could come through, it could just be a quick glance to make sure that we know that it was one mark off or something like that. That would probably have been better" ***(RRN1)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"What you don't want is to have observations done on people that it is not appropriate to have them done? We never got a weigh through. Weight was requested from residents, we don't know why? We thinking: Should we ring AL to tell them to do a weight? But actually, they are a private care home, is it our role to do that? A bit more planning" ***(RRM)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"I think that it is difficult for nurses in a care home who have just taken a set of observations to have another nurse ring up and say we have noticed that this set of observations is a bit lower today" ***(RRM)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"The challenges experience with TH is that it is not structured. Education and awareness is a problem" ***(D6)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"I think that it is useful for AL to have a structure behind a basic set of minimum observations" ***(D1)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"If they got low blood pressure, then call Rapid Response. Are they for hospital admission? Are they for fluids? Do you want us to give fluids subcutaneously? There was no plan for any of these residents" ***(RRM)***	Inadequate Clinical Alignment	Environment-Clinical Alignment	Design Chasm, PEOU, Implementation Process, Facilitating Conditions, Complexibility, Compatibility/Job-Fit, Tech Attributes	Deductive	Lorenzi (2008), Thompson (1991), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (1996, 2000), Ridings and Gefen (2000), Venkatesh (2000), Lee (2003), Rogers (2003), Venkatesh and Bala (2008), Holden and Karsh (2010), Panday (2015), Roger and Shoemaker (1971),	Environmental Context and Resources

"I think that TH should be used end of life span, recurrent chest infections, COPD residents and chronically ill people" ***(D5)***	Future - Diseases	Disease future Intention	Relative Advantage, Perceived Usefullness, Beliefs and Intentions	Deductive	Kelman 1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990),Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Rogers (2003), Davis and Venkatesh (2000), Lee et al. (2003), Holden and Karsh (2010), Venkatesh (2003), Venkatesh and Bala (2008), Parasurman and Colby (2015)	Future Intentions

"COPD residents benefit quite a lot from TH as they panic quite a lot when checking their oxygen levels" ***(RRN1)***	Future Diseases -	Disease future Intention	Relative Advantage, Perceived Usefullness, Beliefs and Intentions	Deductive	Kelman 1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990),Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Rogers (2003), Davis and Venkatesh (2000), Lee et al. (2003), Holden and Karsh (2010), Venkatesh (2003), Venkatesh and Bala (2008), Parasurman and Colby (2015)	Future Intentions

"If we are looking at care homes, the most suited residents for TH will be dementia residents or residents with COPD or heart failure" ***(CN)***	Future - Diseases	Disease future Intention	Relative Advantage, Perceived Usefullness, Beliefs and Intentions	Deductive	Kelman 1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990),Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Rogers (2003), Davis and Venkatesh (2000), Lee et al. (2003), Holden and Karsh (2010), Venkatesh (2003), Venkatesh and Bala (2008), Parasurman and Colby (2015)	Future Intentions

"We are positive about the system, but we need to be using it on all floors" ***(AC1, AC2, AC3, AC4, AC5, AC6)***	Future - Diseases	Disease future Intention	Relative Advantage, Perceived Usefullness, Beliefs and Intentions	Deductive	Kelman 1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990),Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Rogers (2003), Davis and Venkatesh (2000), Lee et al. (2003), Holden and Karsh (2010), Venkatesh (2003), Venkatesh and Bala (2008), Parasurman and Colby (2015)	Future Intentions

"I think that this system would be better suited to medical residents" ***(AM)***	Future - Diseases	Disease future Intention	Relative Advantage, Perceived Usefullness, Beliefs and Intentions	Deductive	Kelman 1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990),Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Rogers (2003), Davis and Venkatesh (2000), Lee et al. (2003), Holden and Karsh (2010), Venkatesh (2003), Venkatesh and Bala (2008), Parasurman and Colby (2015)	Future Intentions

"We need to use it on the medical floor as well, that is, Level 1" ***(AC11)***	Future - Diseases	Disease future Intention	Relative Advantage, Perceived Usefullness, Beliefs and Intentions	Deductive	Kelman 1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990),Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Rogers (2003), Davis and Venkatesh (2000), Lee et al. (2003), Holden and Karsh (2010), Venkatesh (2003), Venkatesh and Bala (2008), Parasurman and Colby (2015)	Future Intentions

"I would use TH on a different floor. I would like to use it on the ground floor as it is more acute medical residents and would be a better choice" ***(RRN2)***	Future - Diseases	Disease future Intention	Relative Advantage, Perceived Usefullness, Beliefs and Intentions	Deductive	Kelman 1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990),Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Rogers (2003), Davis and Venkatesh (2000), Lee et al. (2003), Holden and Karsh (2010), Venkatesh (2003), Venkatesh and Bala (2008), Parasurman and Colby (2015)	Future Intentions

"I think THS is useful for medical residents. I think that it has been fairly successful" ***(AN2)***	Future Diseases -	Disease future Intention	Relative Advantage, Perceived Usefullness, Beliefs and Intentions	Deductive	Kelman 1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990),Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Rogers (2003), Davis and Venkatesh (2000), Lee et al. (2003), Holden and Karsh (2010), Venkatesh (2003), Venkatesh and Bala (2008), Parasurman and Colby (2015)	Future Intentions

"I think TH would be of most benefit to residents with mild and severe dementia" ***(D4)***	Future - Diseases	Disease future Intention	Relative Advantage, Perceived Usefullness, Beliefs and Intentions	Deductive	Kelman 1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990),Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Rogers (2003), Davis and Venkatesh (2000), Lee et al. (2003), Holden and Karsh (2010), Venkatesh (2003), Venkatesh and Bala (2008), Parasurman and Colby (2015)	Future Intentions
"I also think that there needs to be more criteria around it because a weekly blood pressure/heart rate check will not tell you much I would say. I think that if it becomes a pattern that they get done weekly and it will be easy for them to do. I think that untargeted once a week observation of residents is probably of limited benefit because we call, and they say that everything is fine" ***(D1)***	Future - Increased frequency of monitoring, training, feedback, awareness and understanding	Increased intention future: training, usage, feedback, awareness and understanding		Inductive		Future Intentions

"It needs to continue with a purpose and staff need to understand what that purpose is e.g. just doing it two days a week because someone has told them to do that. There needs to be a proper appreciation, understanding and commitment. It needs to be at least five days, that is, every 24 hours" ***(P1)***	Future - Increased frequency of monitoring, training, feedback, awareness and understanding	Increased intention future: training, usage, feedback, awareness and understanding		Inductive		Future Intentions
"TH success is dependent on the care home. I think that all staff need to be aware of it and to understand how it works and what is the purpose of it and to comply with it and support it and ensure that it is running safely and effectively" ***(D4)***	Future - Increased frequency of monitoring, training, feedback, awareness and understanding	Increased intention future: training, usage, feedback, awareness and understanding		Inductive		Future Intentions
"We need to share previous positive experiences of projects with staff and how this project has helped the home progress. This will give them some incentive and increase their motivation" ***(RRN2)***	Future - Increased frequency of monitoring, training, feedback, awareness and understanding	Increased intention future: training, usage, feedback, awareness and understanding		Inductive		Future Intentions
"I would have like there to be more training next time" ***(D6)***	Future - Increased frequency of monitoring, training,	Increased intention future: training, usage, feedback,		Inductive		Future Intentions

	feedback, awareness and understanding	awareness and understanding				
"I think you need to do it in conjunction with the quality and training of staff. Unless that happens, it would help but not that much" ***(D3)***	Future - Increased frequency of monitoring, training, feedback, awareness and understanding	Increased intention future: training, usage, feedback, awareness and understanding		Inductive		Future Intentions
"We can be matched up with the person who knows how to use the system and they can teach us how to use the system" ***(AC11)***	Future - Increased frequency of monitoring, training, feedback, awareness and understanding	Increased intention future: training, usage, feedback, awareness and understanding		Inductive		Future Intentions
"There should have been a definite programme of installation and training, that is, a better roll out programme with review dates" ***(P1)***	Future - Increased frequency of monitoring, training, feedback, awareness and understanding	Increased intention future: training, usage, feedback, awareness and understanding		Inductive		Future Intentions

"AL management needs to ensure that the new staff are trained on how to use the THS" ***(AC13)***	Future - Increased frequency of monitoring, training, feedback, awareness and understanding	Increased intention future: training, usage, feedback, awareness and understanding		Inductive		Future Intentions
"I think that doing it at AL was a mistake. I think going forward it could work in certain areas, maybe AL was not the best place to choose. Rapid Response are for hospital avoidance and you really don't want to spend time going to see that patient when they are in a home that is well supported by trained nurses. I think that Community Matrons are in a better position to manage these residents because they are in nursing homes and nurses are there" ***(RRM)***	Future - Residential or Care Homes	Future Intention Location		Inductive		Future Intentions

"We thought that maybe a residential non-nursing care home or a patient in their own home might be better because they don't have the medical support. It is something that we can see the benefit of and the benefit of residents using it in their own homes. I can definitely see a gap there that we should be using it but we are not even thinking about it" ***(RRM)***	Future - Residential or Care Homes	Future Intention Location		Inductive		Future Intentions
"I am sure that you will have a better success rate because residents in their own homes are very keen to have their blood pressure taken, monitoring and checking where the parameters are. They will enquire if anything is wrong and if below the parameters, they will ask for help from Rapid Response, GP or go to the hospital" ***(RRN2)***	Future - Residential or Care Homes	Future Intention Location		Deductive	Odeh et al. (2013)	Future Intentions

"I do not think that TH is appropriate for a nursing care home because they should automatically be monitoring vital signs whereas residential homes will need prompting and support to be beneficial. I think that TH will be more beneficial in a residential home than a nursing home because there are no nurses in a residential home, but you have key workers in a residential who are not medically trained but are trained to monitor vital signs. I think that we have done a study in patient's private home who have no dementia or memory issues that was more productive." ***(RRN2)***	Future - Residential or Care Homes	Future Intention Location		Inductive		Future Intentions

"I have seen the cases for residential homes and that would make more sense to me in that regard particularly in Croydon where we have a large number of residential homes. I do wonder whether taking the THS out of AL and moving it into a residential non-nursing home would provide more value because that skills set doesn't already exist there. You can train someone to do an automated blood pressure easy and that result gets interpreted elsewhere" (D1a)	Future - Residential or Care Homes	Future Intention Location		Inductive		Future Intentions
*"If you are going to go down a level and go to residential, I think that you are going to do a lot more because that's where they have a low tolerance to send me off to go somewhere if they look a bit unwell. If you have got a mechanism that can monitor, then they will know that that there is some support at the end of a line." **(RRN1)***	Future - Residential or Care Homes	Future Intention Location		Inductive		Future Intentions

"TH makes them more independent. It saves them having to go to their pharmacy or GP or a nurse to come in to take their blood pressure and doing it at a more relaxed time for them" ***(RRN1)***	Future - Residential or Care Homes	Future Intention Location		Inductive		Future Intentions
"I don't think that TH should be a priority to a care home. I think that the priority to a care home should be advanced care planning and clinical skills, empowerment of the nurses to complete the plans of care. If they have been given the autonomy to stick with what has been planned, then actually we shouldn't need the TH, or we could use something in a different format to support clinical decision making and keeping to the plans. I can't use TH as a panacea for any care that has not been met in a nursing home" ***(CN)***	Future - Residential or Care Homes	Future Intention Location		Inductive		Future Intentions

"I think that the whole idea of being able to monitor your own health at home is of value and possibly for care homes that wouldn't have nurses on site, this would be something that we would look at in the future. I think that there is a gap in the market there. I think that we under use it" ***(RRM)***	Future - Residential or Care Homes	Future Intention Location		Inductive		Future Intentions
"Definitely make sure that we were receiving the information. We need to ensure that all the correct information is being transmitted and that everything is in place and to give us the parameters to begin with" ***(RRN1)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"We could use wristbands instead which might be less uncomfortable. We can maybe use different temperature probes" ***(CN)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"I think the scanning thermometer would have been better for older residents especially with dementia or some sort behaviour problem as a probe thermometer was not accepted" ***(RRN2)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions

"I think that TH could be a tool, but I think for a targeted cohort of residents e.g. if I am changing medication I would want to know what the observations are over the next week or two and it would be nice to look at them remotely so that I don't have to call anyone" ***(D1)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"We could go forward and start doing things like blood sugar monitoring for our diabetic residents as well. There is lots of areas in which it could open up opportunities" ***(RRN1)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"I think that one machine is not enough. We need one machine per a floor" ***(AC3)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"Who is this service for? I am not sure that we are clear who this service is for? It's for the benefit of the residents, I get that. Who is it trying to help? Is it aiming to help the GP? TH is a tool. Is it a tool to help Rapid Response? Is it a tool to help AL? Where does TH fit in?" ***(D1)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions

"Then they will be on their toes because they have to fill a sheet in every time. I have not seen one sheet, in AL. No one in AL has shown me what they do for TH" ***(D6)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"By putting a machine in there, it is not going to work. If you run it the same way it will not succeed, the working ethics has to change" ***(D6)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"It's about having system in place so that the patient doesn't fall through the gap. I think it is who monitors that concerns me because although we have staff who work seven days a week, we are very much a reduced service on weekends and that's when our residents and homes get vulnerable because there isn't that back up from GP" ***(RRM)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"It would be nice for those residents to have a plan that they are not for hospital admission, but they are for oral antibiotics. I don't think that was done. But, trying to unpick that: Do they have an advanced care plan or are they for hospital admission?" ***(RRM)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions

"We need to link TH with an understanding of Do Not Attempt Resuscitation and advanced care planning, that is, a whole systems approach but not only based on the THS. I think that if you can make them patient specific, then they will be much more meaningful. With that, we have to have an education programme, advanced care planning for residents, DNAR's, clinical scenarios e.g. if this happens, this is what you do and then we have conversation over a tablet in real time" ***(CN)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"I would like to move a project forward, but I am feeling quite frustrated that we do not have the infrastructure or money or the formal direction. I would like to see a proper strategy with proper direction and resources to support it. I have been given this project on top of my usual day work but acknowledging that I have no additional time to do it. My involvement will be very limited and because we don't have a strategy really and	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions

*no additional funding has been granted to do that" **(CN)***						
*"There are other ways that the admission rate can be tackled using this technology but not necessarily in this format" **(CN)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions

"There needs to be a change in culture as to how we manage these people as well as to providing the personal and medical care plans and support services for which telemedicine can fit into. Providing telemedicine and saying someone else will look at the observations is a particularly useful tool. I think that it needs to be part of a wider transformation piece that includes the home and wider support services" ***(D1)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"Implementing new services is relatively easy but actually embedding it within the existing services is actually hard. TH when utilised in care homes needs to be accessible by other support services" ***(D1)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions

"People will say that there are lots of services commissioned for care homes, so it's how do we get the teams working better. We have to consider what is its role and where does it fit in within the bigger picture in Croydon. How does it fit and supplement and complement other services including the staff from the care homes? Staff from care homes are woefully undervalued and I don't want to take away from their professional status. It needs to be a tool that works for them as well as us" ***(D1)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"Information is going to make a difference to the management of the resident and the care plan is" ***(D2)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"They should already have parameters on all their residents within their notes/documentation that this is their normal or abnormality and they should know who to report to e.g. the GP or Rapid Response because they have got support here. You can take TH out but make sure that your	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions

staff are doing observations on identified residents" (RRN1a)						
"I would suggest, if you could change the days e.g. Thursday and Friday but to my knowledge Rapid Response review the data at the end of the week so it is going to be a bit difficult for both of us" ***(AN1)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions

"I would like to get a print out of the record of the vital observations once I have done them, it will assist me as I usually have to write them down repeatedly. I take the vitals observations every week, but I don't have a record of it. If we have a printed record, we can keep it in the resident's folder, so I can refer to the previous recordings immediately and compare the previous recording to the current vital observations taken. Currently, I am only notified of the difference when Rapid Response contact me" ***(AN1)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"TH is part of a system, but it should only be used in nursing home to help support that clinician's decision rather than disempowering them and using the machine only" ***(CN)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions

"I prefer a care home to use all the services that are available, not only the emergency services. If the THS can improve the use of our service in the correct way e.g. to ensure that that their handovers are knowledgeable, concise and through. If it is used as a learning tool, it is good" ***(P1)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"I am happy with the current structure of TH at AL as Rapid Response do an amazing job" ***(D5)***	Future Clinical Alignment	Future Clinical Intention		Inductive		Future Intentions
"We can continue to use TH at AL if all parties are willing to adapt and work together especially management and the GP's" ***(RRN2)***	Future HCP collaboration	Future Collaboration Intentions		Inductive		Future Intentions
"We never got to see parameters because we never got access to the system. It might have been quite nice if we sat with our Geriatrician to set parameters" ***(RRM)***	Future HCP collaboration	Future Collaboration Intentions		Inductive		Future Intentions

"Any new service should be clearly be brought into a forum e.g. a network. We need to explain who is going to do this. Why are we doing it? What are the benefits of doing it? How long are we going to be doing it? How are going to look at the results and who are the users?" ***(D6)***	Future HCP collaboration	Future Collaboration Intentions		Inductive		Future Intentions
"I would like my nurse in my surgery to have system access but there needs to be provision made for more time in addition to what we are doing rather than instead of" ***(D5)***	Future HCP collaboration	Future Collaboration Intentions		Inductive		Future Intentions
"I would just do the beginning of TH differently. We have a meeting on a Monday, someone could come in and tell us about it and say we have got residents? Would you like to be involved in choosing the residents? I think give a bit more ownership to staff that are involved. I think going forward, if we were to do it again, people will happy to but it would be nice to have that little bit more involvement" ***(RRM)***	Future HCP collaboration	Future Collaboration Intentions		Inductive		Future Intentions

"They can use the THS as a real time consultation with clinician about a patient that they are concerned about. I want them to tell me to what the blood pressure is and why they are concerned about it. I want the technology to support their clinical decision making and the professional communication" ***(CN)***	Future HCP collaboration	Future Collaboration Intentions		Inductive		Future Intentions
"Management and the CCCG should dedicate time into the GP workload for TH" ***(D5)***	Future Support	Future Support Intentions		Inductive		Future Intentions
"We recorded a text message or phone call on a spreadsheet, but it was not appropriate to put them onto EMIS. Going forward, if we were going to do a pilot again, or if it was trialled anywhere else, we would have to put those residents in a separate area e.g. long-term conditions or TH area in EMIS. We could learn from that for next time" ***(RRM)***	Future Support	Future Support Intentions		Inductive		Future Intentions
"It's about changing parameters half way through and who is going to do that, that is, who is the right person to do that?" ***(RRM)***	Future Support	Future Support Intentions		Inductive		Future Intentions

"Having somebody in their own group telling them the importance of TH would be more successful rather than an external person coming in. Two designated key workers that are in charge during the two days that they are monitoring. Their responsibility is to cascade the reasons to staff as to why we are using TH so that staff have a better understanding of why they are using TH. Some staff will do that and that's why I have key staff in mind that will own this project and result in a better response from the staff" ***(RRN2)***	Future Support	Future Support Intentions		Inductive		Future Intentions
"You have to ensure that the senior nurses have a complete understanding so that they can then disseminate their knowledge and that is how we are trying to work now. Senior nurses disseminate learnings to other staff" ***(P1)***	Future Support	Future Support Intentions		Inductive		Future Intentions

"There needs to be a dedicated role to have the freedom to implement a THS that meets the needs of Croydon. Whether we are looking at residential or nursing homes, we need money and research underpinning it. We want it to move forward and be evaluated properly under supervision of a dedicated role" ***(CN)***	Future Support	Future Support Intentions		Inductive		Future Intentions
"The external person could come in once TH has started and support the key residents and that would be a better approach. They need staff within their home running it and someone supervising the TH project. We need to constantly review the residents that are in the research because some of them experience changes and pass away" ***(RRN2)***	Future Support	Future Support Intentions		Inductive		Future Intentions
"We should have a refresher training day for the staff who missed out. We need to refresh training every three months because of new staff coming in and staff on leave" ***(AC11)***	Future Support	Future Support Intentions		Inductive		Future Intentions
"Management needs to engage better. Failure to engage is a failure" ***(D6)***	Future Support	Future Support Intentions		Inductive		Future Intentions

"This could highlight to AL management that actually it is beneficial to do observations on certain residents. That would help every floor in there rather than the specific floor that they have done" ***(RRN1)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"TH is a support for us and the residents" ***(AN1)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

"The technology makes our lives easier" ***(AC8)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"I think that it improved the quality of the medical care that we provide" ***(AC5)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

"There was a carer who used the THS just before the doctor did his rounds and the system detected that the resident's blood pressure was a bit high and this was brought to the attention of the doctor and dealt with" ***(AC11)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"This is quicker than a 111 call" ***(AC4)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

"I think that TH improved the service levels at AL" ***(RRN2)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"TH could have prevented more hospital admissions or if you are treating any health deterioration, we have involved the GP in the initial stage and provide appropriate treatment here instead of sending them to the hospital" ***(AN1)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

"I think that the increased involvement from Rapid Response has assisted in decreasing hospital admissions" ***(AN1)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"The THS had an impact on the residents because it picked up that some readings were a pattern and not a once of reading as we took the readings weekly e.g., we had one resident who had consistently low blood pressure and pulse" ***(AN2)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

“I think that the THS has impacted on the service and the relatives and GP’s of residents were impressed with the system and creates a perception of good care received” ***(AN2)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"We can provide more support for residents and if there are any changes, we can easily record it and rectify it and thus helped me allot. I think that THS helps us to pick up the initial signs so that we can give appropriate treatment or support for them. It was really helpful for that” ***(AN1)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

“At least I know for myself that my residents’ blood pressure has been taken once a week. I have peace of mind knowing that blood pressure has been checked" ***(AM)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
“By the presence of the processes, they are being more facetious with their processes internally” ***(D1)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

"They have an accurate record of the past history and vital signs, so they can compare easily how their condition is" ***(AN1)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"We would have not been doing the vital stats every week but rather once a month. The THS makes us monitor the vitals weekly, rather than monthly" ***(AN2)***	Improved Clinical Effectiveness	Belief of Improved Clinical Effectiveness	Objective Usability, Job Relevance, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

"TH should be a priority for dementia residents as they are not able to express when they are unwell so if you are monitoring them regularly, you can easily identify any changes in their condition. Otherwise, we will only identify it in the last stage whereas with TH, we can identify a change in health status in the first stage. I think that THS helps us to pick up the initial signs so that we can give appropriate treatment or support for them. It was really helpful for that" ***(AN1)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"TH should be a priority for a care home as it makes you monitor resident's vital observations weekly whereas we would only do them monthly and you can identify something immediately that you would have only picked up next month" ***(AN2)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

"I think that the THS changed our service levels through faster diagnosis" ***(AC6)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"The system has reduced our workload and stress" ***(AC11)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

"We can be faster to save our residents" ***(AC1, AC3, AC5, AC6)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"I think that the system might be useful to assist us in getting a quick response e.g. if someone was not feeling well" ***(AC2)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

"The THS was helpful if someone was not feeling well and we could get a quick recommendation rather than waiting for a doctor to come in and examine that patient and go away, make up a prescription and then we have to go and collect the prescription. This is a quicker way of diagnosing someone" ***(AC4)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"Is quicker than the old system" ***(AC13)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

"It reduces the work of the nurse and Rapid Response gives more support to each other" ***(AN1)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"I was concerned that I will have enough time to use the THS. When I started using the system, 80% of my fears did not come true" ***(AN2)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

"The THS helps our residents as it picks up immediately what is going on with residents" ***(AC11)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"Faster diagnosis and help save that person. This is quicker than a 111 call" ***(AC4)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

"I think that the THS changed our service levels through faster diagnosis" ***(AC6)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"The THS is much quicker, and we can get results faster especially blood pressure. I enjoyed working with the THS as it is much faster." ***(AC13)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs

"All carers would like to use it on all residents as it helps them to keep a record of everything" ***(AC1, AC2, AC3, AC4, AC5, AC6)***	Improved Clinical Efficiency	Belief of Improved Clinical Efficiency	Objective Usability, Perceived Ease of Use, Performance, Perceived Usefulness, Relative Advantage, Long-term Consequences	Deductive	Davis et al. (1989), Davis (1989), Venkatesh (2000), Thompson (1991), Adams (1992), Igbaria et al. (1995), Chau (1996), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Venkatesh (2003), Rogers (2003),	Goals and Beliefs
"I felt from the very beginning that implementing TH in this way would have very little benefit" ***(CN)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs
"I don't know if it has promoted a culture change at AL, but I am not aware of any cases that have had changes to their clinical care based on TH" ***(D1)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs
"I am not sure if TH had a major impact on AL service levels" ***(RRM)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs

"I don't think that TH has had a big impact on anything or prompted any different care unless by the presence of the processes, they are being more facetious with their processes internal" ***(D1)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs
"TH might be useful for a certain group of residents but not for mine" ***(D2)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs
"TH had no impact on my home visits and assessments" ***(D6)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs
"I thought that TH would have been more impactful but that hasn't turned out to be the case" ***(D3)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs
"The THS made no difference to the residents at AL under my care because they do not have conditions that need that sort of monitoring" ***(D2)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs

"I haven't noticed any difference in the call rate" ***(P1)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs
"The THS had no impact on me" ***(D1)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs
"I have seen this THS being implemented but it hasn't impinged on my day to day working" ***(D3)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs
"The current THS at AL had no impact on my work because no one has contacted me" ***(D2)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs
"The THS going into AL did not support my job" ***(RRN1)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs

"I could not allocate a change in call rates to TH" ***(P1)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs
"TH has not helped me to do my job because it was only installed in one nursing home, which is AL" ***(D6)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs
"It didn't have the impact on us that we thought it was going to" ***(RRN1)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs
"I'm not sure if it had a massive impact on AL to be perfectly honest" ***(RRN1)***	Inadequate Clinical Effectiveness	Belief of Inadequate Clinical Effectiveness	Implementation process,Results Demonstrability, Trialability, Assessment Chasm	Deductive	Davis and Venkatesh (1996), Lorenzi (2008), Rogers (2003),	Goals and Beliefs

"We were told that Rapid was doing this and that it would be extra work. We expected to be far busier than we were" ***(RRN1)***	Less workload than expected	Belief of Less workload than expected	PEOU, Effort Expectancy, Performance, Relative Advantage	Deductive	Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Rogers (2003), Venkatesh et al. (2003), Venkatesh (2003), Venkatesh and Bala (2008), Panday (2015),	Goals and Beliefs
"We thought that TH would make us a lot busier" ***(RRN1)***	Less workload than expected	Belief of Less workload than expected	PEOU, Effort Expectancy, Performance, Relative Advantage	Deductive	Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Rogers (2003), Venkatesh et al. (2003), Venkatesh (2003), Venkatesh and Bala (2008), Panday (2015),	Goals and Beliefs

"I did think that there would be an increased work load but there were hardly any residents being monitored" ***(D5)***	Less workload than expected	Belief of Less workload than expected	PEOU, Effort Expectancy, Performance, Relative Advantage	Deductive	Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Rogers (2003), Venkatesh et al. (2003), Venkatesh (2003), Venkatesh and Bala (2008), Panday (2015),	Goals and Beliefs

"My understanding of TH has changed as it makes life easier" ***(AC8)***	Improved Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2000), Venkatesh et al. (2000), Davis et al. (2000), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), French and Raven (1959), Malhotra et al. (1999), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015)	Knowledge, Awareness and Understanding

"I can learn and then apply what I learn to help my residents" ***(AC5)***	Improved Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2000), Venkatesh et al. (2000), Davis et al. (2000), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), French and Raven (1959), Malhotra et al. (1999), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015)	Knowledge, Awareness and Understanding

"Our healthcare assistants who can learn a lot from e.g. taking a blood pressure, using a thermometer. It makes healthcare assistants confident" ***(AN2)***	Improved Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2000), Venkatesh et al. (2000), Davis et al. (2000), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), French and Raven (1959), Malhotra et al. (1999), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015)	Knowledge, Awareness and Understanding

"TH is promoting good technique that is, getting them to understand the way to do good observations and the reasons behind it. They will start to see that they are hot to touch, or their pulse is a bit erratic e.g. their breathing is laboured. We see things that even before our machinery has even reported it to us" ***(P1)***	Improved Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2000), Venkatesh et al. (2000), Davis et al. (2000), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), French and Raven (1959), Malhotra et al. (1999), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015)	Knowledge, Awareness and Understanding

"When you ring up, actually the carers have either repeated the observation or acted upon them and actually there isn't a lot to be done" ***(D1)***	Improved Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2000), Venkatesh et al. (2000), Davis et al. (2000), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), French and Raven (1959), Malhotra et al. (1999), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015)	Knowledge, Awareness and Understanding

"My experience of TH at AL has been completely different" ***(RRN1)***	Improved Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2000), Venkatesh et al. (2000), Davis et al. (2000), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), French and Raven (1959), Malhotra et al. (1999), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015)	Knowledge, Awareness and Understanding

"I can see the value of TH…our awareness has come up" ***(AM)***	Improved Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2000), Venkatesh et al. (2000), Davis et al. (2000), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), French and Raven (1959), Malhotra et al. (1999), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015)	Knowledge, Awareness and Understanding

"They actually understanding the systolic and diastolic reading for blood pressure and the meaning of that reading to that specific patient. That was the learning that I was hoping would develop" ***(P1)***	Improved Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2000), Venkatesh et al. (2000), Davis et al. (2000), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), French and Raven (1959), Malhotra et al. (1999), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015)	Knowledge, Awareness and Understanding

"I felt good using it and I learnt something new" ***(AC12)***	Improved Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2000), Venkatesh et al. (2000), Davis et al. (2000), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), French and Raven (1959), Malhotra et al. (1999), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015)	Knowledge, Awareness and Understanding

"This system gives us more knowledge" ***(AC13)***	Improved Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2000), Venkatesh et al. (2000), Davis et al. (2000), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Triandis (1980), Lucas et al. (1990), French and Raven (1959), Malhotra et al. (1999), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015)	Knowledge, Awareness and Understanding
"*Some of the staff don't know the purpose of the THS. Why are we only using it on one floor, that is, a dementia floor?****"*** ***(AC7)***	No change in Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding		Inductive		Knowledge, Awareness and Understanding
"I don't think that my understanding of the TH has changed much as we used to	No change in Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding		Inductive		Knowledge, Awareness and Understanding

have a similar system at the surgery some time ago" ***(D3)***						
"I don't think the staff at AL understand much about TH" ***(RRN2)***	No change in Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding		Inductive		Knowledge, Awareness and Understanding
*"My understanding of TH hasn't really changed" (**RRN1)***	No change in Knowledge, Awareness and Understanding	Effect on Knowledge, Awareness and Understanding		Inductive		Knowledge, Awareness and Understanding

"I don't think that AL found it particularly difficult to use the equipment" ***(RRM)***	Ease of Use	Easy Memory and Reinforcement	Self-Efficacy, Perceived Behavioural Control, PEOU, Beliefs	Deductive	Bandura (1977), Igbaria et al (1995), Yi et al. (2003), Li et al. (2003), Kelman (1958), Schum (1968), Taylor et al. (1995), Bandura (1997), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Venkatesh and Bala (2008), Panday (2015)	Memory and Reinforcement

"At the start it was difficult, now my staff are used to the system and it is easy" ***(AM)***	Ease of Use	Easy Memory and Reinforcement	Self-Efficacy, Perceived Behavioural Control, PEOU, Beliefs	Deductive	Bandura (1977), Igbaria et al (1995), Yi et al. (2003), Li et al. (2003), Kelman (1958), Schum (1968), Taylor et al. (1995), Bandura (1997), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Venkatesh and Bala (2008), Panday (2015)	Memory and Reinforcement

"It was not hard to use. I found it easy" ***(AC12)***	Ease of Use	Easy Memory and Reinforcement	Self-Efficacy, Perceived Behavioural Control, PEOU, Beliefs	Deductive	Bandura (1977), Igbaria et al (1995), Yi et al. (2003), Li et al. (2003), Kelman (1958), Schum (1968), Taylor et al. (1995), Bandura (1997), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Venkatesh and Bala (2008), Panday (2015)	Memory and Reinforcement

"When I got to know the system, I realised that it is very easy, I can do the job myself. The first day someone had to teach me how to use it but after that I found it easy" ***(AC7)***	Ease of Use	Easy Memory and Reinforcement	Self-Efficacy, Perceived Behavioural Control, PEOU, Beliefs	Deductive	Bandura (1977), Igbaria et al (1995), Yi et al. (2003), Li et al. (2003), Kelman (1958), Schum (1968), Taylor et al. (1995), Bandura (1997), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Venkatesh and Bala (2008), Panday (2015)	Memory and Reinforcement

"I was very keen to learn the THS and found it dead easy" ***(AC8)***	Ease of Use	Easy Memory and Reinforcement	Self-Efficacy, Perceived Behavioural Control, PEOU, Beliefs	Deductive	Bandura (1977), Igbaria et al (1995), Yi et al. (2003), Li et al. (2003), Kelman (1958), Schum (1968), Taylor et al. (1995), Bandura (1997), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Venkatesh and Bala (2008), Panday (2015)	Memory and Reinforcement

"When I was taught by the nurses, I realised that it is very easy" ***(AC13)***	Ease of Use	Easy Memory and Reinforcement	Self-Efficacy, Perceived Behavioural Control, PEOU, Beliefs	Deductive	Bandura (1977), Igbaria et al (1995), Yi et al. (2003), Li et al. (2003), Kelman (1958), Schum (1968), Taylor et al. (1995), Bandura (1997), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Venkatesh and Bala (2008), Panday (2015)	Memory and Reinforcement

"Initially, I thought that TH will be really difficult but as I used the system, I felt that it was simple" ***(AN1)***	Ease of Use	Easy Memory and Reinforcement	Self-Efficacy, Perceived Behavioural Control, PEOU, Beliefs	Deductive	Bandura (1977), Igbaria et al (1995), Yi et al. (2003), Li et al. (2003), Kelman (1958), Schum (1968), Taylor et al. (1995), Bandura (1997), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Venkatesh and Bala (2008), Panday (2015)	Memory and Reinforcement

"Sometimes it doesn't come on, there is a password. You have to scan the card and sometimes that doesn't work. Once we got it going, it is fine" ***(AC8)***	Ease of Use	Easy Memory and Reinforcement	Self-Efficacy, Perceived Behavioural Control, PEOU, Beliefs	Deductive	Bandura (1977), Igbaria et al (1995), Yi et al. (2003), Li et al. (2003), Kelman (1958), Schum (1968), Taylor et al. (1995), Bandura (1997), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Venkatesh and Bala (2008), Panday (2015)	Memory and Reinforcement

"I enjoyed using the THS. I found it difficult initially and it is so computerised, and I took a long time to learn it" ***(AC14)***	Ease of Use	Easy Memory and Reinforcement	Self-Efficacy, Perceived Behavioural Control, PEOU, Beliefs	Deductive	Bandura (1977), Igbaria et al (1995), Yi et al. (2003), Li et al. (2003), Kelman (1958), Schum (1968), Taylor et al. (1995), Bandura (1997), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Venkatesh and Bala (2008), Panday (2015)	Memory and Reinforcement

"Initially the THS was difficult to use because the machine took a long time for the reading. When taking blood pressure readings, I couldn't take the temperature at the same time. I had to wait for the blood pressure vital readings to complete be taken before I could take the temperature. If I take the readings manually, I can take the temperature, pulse and blood pressure at the same time and enter the readings manually" ***(AN1)***	Ease of Use	Easy Memory and Reinforcement	Self-Efficacy, Perceived Behavioural Control, PEOU, Beliefs	Deductive	Bandura (1977), Igbaria et al (1995), Yi et al. (2003), Li et al. (2003), Kelman (1958), Schum (1968), Taylor et al. (1995), Bandura (1997), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Venkatesh and Bala (2008), Panday (2015)	Memory and Reinforcement

"The THS is a part of us now" ***(AN2)***	Technology Adoption	Reinforced Technology Adoption	Self-Efficacy, Culture, Perceived Behavioural Control, PEOU, Beliefs	Deductive	Bandura (1977), Igbaria et al (1995), Yi et al. (2003), Li et al. (2003), Kelman (1958), Schum (1968), Taylor et al. (1995), Bandura (1997), Triandis (1980), Lucas et al. (1990), Holden and Karsh (2010), Parasuraman and Colby (2015), Davis (1992), Sears (1993), Barki (1994), Igbaria (1995), Agarwal (1999), Davis and Venkatesh (2000), Ridings and Gefen (2000), Venkatesh (2000), Venkatesh and Bala (2008), Panday (2015)	Memory and Reinforcement

"The good thing is that you develop a relationship because it was the same people that we were talking to every week" ***(RRM)***	Improved HCP relationships	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"Now, we receive a call back. In the past there was no contacting us" ***(AM)***	Improved HCP relationships	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"The implementation of TH has encouraged more external healthcare professionals to support AL" ***(AM)***	Improved HCP relationships	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"The communication has gotten better e.g. when they contact the GP or are on a GP ward round on Tuesdays and Wednesdays, they have the vital signs available" ***(RRN2)***	Improved HCP relationships	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"The THS has assisted us to build up a good relationship with AL" ***(RRN1)***	Improved HCP relationships	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"Rapid Response was there to support us by monitoring the vitals. It was an extra support as compared to just having the GP. Previously, there was no support until I requested support from the GP" ***(AN1)***	Improved HCP relationships	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"We know that someone else is monitoring and supporting us and our residents as a home for health and safety. We do not make decisions alone; our decisions are supported by Rapid Response" ***(AM)***	Improved HCP relationships	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"By the time we phone them, things have been rectified and sorted so it hasn't actually had a big impact on our work load which the expectation was when it first happened. We were quite apprehensive" ***(RRN2)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"We feel more involved. We feel like we are a part of AL nursing team. If somebody ask you to take the observations and you can do it, you feel good and you feel confident that you can do something, and it helps the residents" ***(AC11)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"TH is the first tool that shows us a change in the vital signs or health status of a resident with dementia. It is really helpful to give dementia residents the appropriate treatment" ***(AN1)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"I had a discussion with the GP and relatives, and they have feedback that this was normal for this resident and there was a family history of this as well. Initially we were panicking but the family reassured us that this is normal, that is, the son has it as well. We discussed it with the GP so that the GP is also aware of the medical history" ***(AN2)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"I personally think that this could enhance the level of nursing care and enhance the level of decision making that the nurses have" ***(CN)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"I think that monitoring using the system, gives you an idea of what's happening there and then. Once you are aware of what is happening, you can take it further" ***(AC11)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"TH has impacted on my job because if the staff tell me that a patient is unwell with some data, it makes my job easier and I can use that information to make a clinical judgement as to what kind of line of treatment is required" ***(RRN2)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"The personal impact that the THS has on my job is that I was able to use the system to teach the healthcare assistants and activity co-ordinators how to take observations. They have felt that they have learned something new through me" ***(AN2)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"If it came out as an abnormal reading on the TH equipment, they would just repeat the reading on their own equipment" ***(RRM)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"The good thing is that in the latter part of the study, they were questioning the TH results which they won't have done before TH, this was very good" ***(RRN2)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"It probably highlights to them that something is abnormal, so they repeat it" ***(RRN1)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"Confident handover and they can produce all these observations and we can tell that they are not normal observations, but we can see that their boundaries for normal observations is different" ***(P2)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"Towards the end we can see the maturity in the staff who questioned the reading and there would be alarmed or send the person into hospital because they will say that the vital signs are low or beyond parameters. If the person was fine, it was asymptomatic and the message to the GP or to Rapid Response was that they very confidently said "I know that the vital sign that you got for the person is low, but the person is fine" ***(RRN2)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"The fear was that you would take responsibility away from the carers. I don't think that we have seen that. The feedback that I have received, is that they have been quite sensible and that they have taken ownership and made sure that the observations have actually been repeated and more accurate" ***(D1)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"They were very sensible to say that actually we have retaken them, and that this person is fine" ***(RRN1)***	Improved Professional Role	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

"We don't want TH to result in healthcare professionals becoming reliant on what the machine tells you but to help improve in their knowledge and prompt them so that they see a change in resident's demeanour before they have even done the observations" ***(P1)***	Loss of Professional Skill	Improved HCP Role and Identity	Job Relevance, Perceived Usefulness, Social Influence, Experience, Observability, Beliefs, Culture	Deductive	Thompson (1991), Davis and Venkatesh (2000), Venkatesh and Bala (2008), Davis et al. (1989), Davis (1989), Adams (1992), Igbaria et al. (1995), Venkatesh and Bala (2008), Kelman (1958), Schum (1968), Bandura (1977), Lucas et al. (1990), Triandis (1980), French and Raven (1959), Malhotra et al. (1999), Davis and Venkatesh (2000), Venkatesh et al. (2000), Holden and Karsh (2010), Rogers (2003), Parasuraman and Colby (2015), Straub (1994), Gefen and Straub (1997)	Professional Role and Identity

Appendix 14: Cognitive, Functional and Behavioural Assessment Scales[204,205]

Domain	Code	Scale	Items	Points	Format	Analysis	Uses
Cognition (Memory, Orientation, and language)	**MMSE**	Mini Mental State Examination	6	30	Clinician administered patient evaluation	Mild dementia = 20 to 24 points; Moderate dementia = 13 to 20 points; Severe dementia ≤ 12 points	Eligibility screening and dementia staging.
	ADAS- cog	Alzheimer's Disease (AD) Assessment Scale-cognitive subscale	11	70	Clinician administered patient evaluation	Higher Score=Worse	Moderate-Severe AD
	SIB	Severe Impairment Battery	40	100	Clinician administered patient evaluation	Higher Score=Better	Mild-moderate AD
Global Change from baseline to endpoint	**CGI-C**	Clinical Global Impression of Change	3	7	Clinician rated, based on patient +/- informant interview	1 = very much improved, 4 = no change, 7 = very much worse	Measures illness severity (CGIS), global improvement or change (CGIC) and therapeutic response.
	CIBIC-Plus	Clinician's Interview-Based Impression of Change Plus Caregiver Input	8	7	Clinician rated (with caregiver input), based on semi-structured interview.	2 = very much improved, 4 = no change, 7 = very much worse	Cognition, behaviour, function.
	GDS	Global Deterioration Scale	14	7	Clinician rated based	1 = no decline, 7 = very severe decline	Classifies Alzheimer's disease into seven

					on cognitive change only		stages of cognitive function.
Function Activities of daily living (basic and instrumental)	**ADCS-ADL**	Alzheimer's Disease Cooperative Study Activities of Daily Living (ADL)	19	54	Informant rated interview of 27 basic and instrumental ADL's	Higher Score=Better	Mild – moderate AD; a subgroup of 19 validated items has been used in moderate-severe AD
	DAD	Disability Assessment for Dementia	6	100	Informant rated interview of 17 basic and 23 instrumental ADL's	Higher Score=Better	Initiation, organization, and planning
	Bristol ADL	Bristol Activities of Daily Living Scale	20	60	Informant rated interview of 20 items (10 ADL's, 10 IADL's)	Each item rated on a 0-3 pt. scale. Higher Score=Worse	Measure the ability of someone with dementia to carry out daily activities
Behaviour (Mood , behaviour, personality changes)	**NPI**	Neuropsychiatric Inventory	12	144	Informant interview of 12 symptom domains	12-pt. scale based on Frequency (0-4) x Severity (0-3). Higher Score=Worse	Clinical trials of antidementia agents
	CMAI	Cohen-Mansfield Agitation Inventory	29	203	May be self-administered by a caregiver or it may be	The scale ranges from 1 =the participant never engages in the specific agitated behaviour to 7= the	Assesses agitated behaviours of wandering, physical aggressions, inappropriate

					completed by interviewing a staff of family caregiver. Responses are based on observation of individual.	participant manifests the behaviour on the average of several times an hour. The scales are looked over and recommendations are made to reduce areas that are associated with agitated behaviour.	vocalizations, hoarding items, sexual disinhibitions, and negativisms in patients with cognitive impairment.
	CSDD	Cornell Scale for Depression in Dementia	19	38	The clinician interviews the resident and the resident's caregiver.	>10 probably major depressive episode. >18 definite major depressive episode	Screening tool for Depression in Dementia
	BEHAVE- AD	Behavioural symptoms in Alzheimer's disease	25	75	Informant interview of 25 behavioural symptoms	Rated on a 0-3 pt. scale. Higher Score=Worse	Measures behavioural and psychological symptoms of dementia in patients with Alzheimer's disease (AD)

Appendix 15: OPTIMAL Patient Information Sheet

Patient Information Sheet

Title of Study: ***OPTIMAL: Effectiveness of discharge advocate to reduce readmission***

We are conducting a new research Study at [Local Hospital] called OPTIMAL. This aims to see if having Patient Discharge Advocates (PDAs) reduces the number of people who need to be re-admitted to hospital.

We would like to invite you to take part in this research. Please take time to read the following information carefully before deciding whether or not to participate because we want you to understand why the Study is being done and what it will involve.

If, after reading this Information Sheet, you are still unsure or uncertain about anything, then we will be happy to answer any questions you may have.

Background and Purpose of the Study
Hospital re-admission can cause distress and frustration to patients, along with disruption to their personal lives. In 2012-2013, 5-12% of emergency admissions were re-admissions, costing the NHS around £2.4 billion. It is, therefore, beneficial to us all that we investigate ways to support patients to avoid early hospital re-admissions. This Study – OPTIMAL – has been designed to investigate the effectiveness of a post-discharge telephone consultation with a trained PDA, together with the patient's normal planned discharge package. The PDA will contact 50% of patients willing to take part during the first week after they have been discharged. During this consultation, the PDA will check how the patient is managing at home, if additional support is required and whether they have access to and understand their medication. If it is thought to be beneficial, the patient may be referred to other relevant services to support them. The phone call will also be used to check if patients have received or attended planned appointments.

Why Have I Been Invited to Take Part?
You have been invited to take part in this study because you are about to be discharged. The aim of this study is to see if we can avoid a future re-admission of recently discharged patients by using a Patient Discharge Advocate within the discharge process. You therefore fulfill this criteria, hence why you have been invited to take part.

Do I Have to Take Part?
No. This research Study is done purely on a voluntary basis.

Can I Drop Out Later if I Don't Want to Carry on With it?
Yes. If you choose to take part after reading this Information Sheet, we will ask you to sign a consent form. However, you are free to withdraw from this Study at any point without disadvantage and without having to provide a reason.

What Will Happen if I Take Part in the Study?
There will be no change in your current care or discharge plan. Consenting patients will be randomly assigned to one of two groups: One group of patients will receive the usual post-

discharge care according to their Care Plan. The second group will receive support from a PDA.
If you are in the group who will be supported by the PDA, then before you are discharged, the PDA will introduce themselves to you and ensure your post-discharge care is in place. A few days after you leave hospital, the PDA will telephone you to discuss how you are managing since leaving hospital. You may receive some suggestions on how to best direct your care, which could help prevent your re-admission. These telephone calls are not expected to last longer than 15 minutes. If during this initial telephone call it is deemed that further contact is necessary, you may receive further calls based on your clinical need to ensure that your health needs are fully met. If you do not wish to be contacted again, you are free to ask the PDA not to contact you in the future.

If there are any concerns about your health, then the PDA may ask a member of a support service team to visit you at home, or ask that you be referred to another clinic for review or onto another service. These other services may be in the hospital or at your own GP surgery. You are free to decide on whether you wish to use these services or not: the PDA will only advise you on what options are open to you, using a Directory of Services of services already currently established both in [LOCAL HOSPITAL], as well as within the local community.

Around 200 patients in each group will receive a telephone call 30 days after their discharge and invited to answer a few questions and discuss their post-discharge care. Again, you are free to choose not to participate. Information given to the PDA may be used in your future care, as well used to improve post-discharge care.

During the Study, the clinical data from all patients involved will be routinely collected and anonymised for analysis purposes.

We would also like your permission to use the data we have collected to find out if a computer application using this data can accurately predict which patients may be at more risk of being re-admitted in the future. For this 'validation' part of the Study, all clinical data will be anonymised so that neither you nor anyone else involved in the Study can be identified. You do not have to participate in this validation part of the Study if you do not wish to.

Will my Participation be Kept Confidential?
All information collected during the course of the Study will be kept strictly confidential and in secure storage. Responses to the telephone consultations, comments and opinions on your post-discharge care will be anonymised before analysis so it will not be possible to identify you or any other participant. Only the investigators and [Local Hospital] medical staff will have access to this information. We will notify your GP of your participation.

What are the Possible Benefits of Taking Part?
Your opinions about your post-discharge experiences will be listened to and may help others in the future by improving post-discharge care. You will have contributed to helping health care professionals test the functionality and accuracy of a system which helps support patients after leaving hospital. This may also help to prevent re-admissions. Data collected will be used in the development of a software computer program for risk scoring patients, to see if those deemed high risk they may be at greater risk of re-admission compared to another patient.

What are the Possible Disadvantages and Risks of Taking Part?
None. There are no risks to taking part in this Study. You will receive the same Care Plan whether you participate in this Study or not. You will still be able to access all the health care options as patients not participating in the Study.

What Happens if I Change my Mind During the Study and Wish to Withdraw?

If at any time after you have been enrolled into the Study, you then change your mind, please let us know or mention this to the PDA if they phone you. Withdrawal does not affect the care that you receive either now or in the future*. Furthermore you can withdraw at any time without having to give a reason why you decided to withdraw.*

Are There Any Payments?
There are no payments for participating in this Study.

Who Has Reviewed the Study?
This Study was originally reviewed by Innovate UK who are the funders of the Study and then sponsored to ethics approval at Croydon Health Services NHS Trust. It is only after getting ethical approval that we can now start the Study and formally invite patients to take part.

What Happens When the Study is Over?
The Data collected will be analysed and the findings arising from this Study may be presented at national and international conferences as well as published in scientific journals. As has been said earlier, it will not be possible to identify you or others as results will be anonymous and aggregated for the whole participants' group.

What Happens When the Research Study Ends?
You will be under no obligation to volunteer again. Contact details of the research team are included at the end of this information sheet, should you wish to discuss the findings of the Study.

Who is Organising and Funding This Study?
This Study is part of a joint Study with Croydon Health Services NHS Trust, Exus (a Software Engineering Company) and Kingston University. The Study is funded by Innovate UK.

You can follow our progress on our website: ***www.optimal-project.co.uk*** *as well as see papers arising from this Study.*

For further information or questions, please ask:

[INSERT LOCAL CONTACT DETAILS]

Thank you for taking the time to read this Information Sheet

Appendix 16: OPTIMAL Patient Consent Form

PATIENT CONSENT FORM

Title of Study: ***OPTIMAL: Effectiveness of discharge advocate to reduce readmission***

Please initial

1. I confirm that I have read and understand the Patient Information Sheet dated **02/11/2017, Version 3.7** for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I'm free to withdraw at any time without giving any reason, without my medical care being affected. ☐

3. I agree to taking part in the above study. ☐

4. I agree to the use of my anonymised data for validating the Optimal risk score system. ☐

5. I agree to take part in a follow up telephone interview at the end of the study. ☐

_____	_____	_____
Name of Participant	Date	Signature
_____	_____	_____
Name of Researcher	Date	Signature

1 Copy for patient; 1 copy for file; 1 copy for CRF; 1 copy for notes

Appendix 17: OPTIMAL Patient Questionnaire Post Intervention

1. MRN		
2. Optimal Id		
3. Ward		
4. Sex		
4a. Ethnicity		
5. Age		
6. Admission Nat code		
7. Optimal Risk		
8. Date Admitted (O)		
9. Date Discharged (O)		
10. Length of Stay(O)		
11. Reason for Admittance (C)		
12. Main Diagnosis (Categorise) (C)		
13. Mental Health Flag (C)		
14. How was the patient? (O)		
15. Services Contacted by DA (O)		
16. Services Contacted by Patient(O)		
17. Still Waiting for Appointments? (O)		
18a. Date of first call from discharge co-ordinator		
18b. Date of last call from discharge co-ordinator		

19.No. of times spoken to by discharge advocate	
20.Number, time and date of this call	
21.Person spoken to: Carer, Patient, Kin	
21a. No. of previous admittances (O)	

Taking You Back to Your Discharge:

22. Before you left hospital who provided you with the information related to your discharge? *(please select all that apply)*

- ☐ Doctor
- ☐ Nurse
- ☐ Pharmacist
- ☐ No one

Other (please specify)

23. Were any of your medications changed or were you given any new medications before you left hospital? YES, NO, UNSURE

24. If yes or unsure did someone counsel you about the changes or your new medications before you left hospital? *(please select all that apply)*

- ☐ Doctor
- ☐ Nurse
- ☐ Pharmacist
- ☐ No one

Other (please specify)

25. Did you receive a care plan before you left hospital? YES, NO, UNSURE

Since Leaving Hospital

26. Just after you left hospital how confident did you feel regarding the management of the following?

Please tick one box for each row	Not at all confident	Not confident	Neither	Confident	Completely Confident	Not applicable
Your supply of medicines	☐	☐	☐	☐	☐	☐
Your social care issues eg. cooking, mobility	☐	☐	☐	☐	☐	☐
Your health issues (e.g. What To do if your health gets worse)	☐	☐	☐	☐	☐	☐

27. Were you expecting any **FOLLOW UP** appointments after your recent discharge?	Y/N/UNSURE
28. If Y to 27: Would you mind telling me what these were?	

The Call From the Discharge Advocate

29. Did the discharge advocate explain the purpose of the call?	Y/N/UNSURE
30. Do you think the call was at the right time after you were discharged?	Too early. Just right. Too late
31. Did you feel the length of the call was about right?	Too long. Just right. Too short
32. Did the discharge advocate check that you had **RECEIVED** your follow up appointment dates?	Y/N/UNSURE
33. Did the discharge advocate **CHASE** up any appointments or referrals for you?	Y/N/UNSURE
34. Did the discharge advocate make any **ADDITIONAL** appointments for you? If N go to 36	Y/N/UNSURE

35. If Y to 34: Would you mind telling me what these were? Eg. social care, AGE UK

The Usefulness of the call

36. Do you feel that the discharge advocate understood your health problems? 1 didn't understand to 5 understood fully	1 2 3 4 5
37. Did you find this call helpful? 1 unhelpful to 5 very helpful	1 2 3 4 5
38. What was most helpful?	
39. Was there anything else that you would have liked to discuss with the discharge advocate?	
40. Have you made any other appointments or contacted other services yourself (Since you left hospital)? E.g. GP. If N go to 42	Y/N/UNSURE
41. If Y to 40 would you mind telling me what these were?	
42. Are you still waiting to hear about any appointments? (If N go to 44)	Y/N/UNSURE
43. If so, please could you tell me what these are?	
44. Have you been admitted to CUH before? (If N go to 47)	Y/N/UNSURE
45. How did your support during this discharge compare to your last discharge? On a scale of 1-5 1 Worse 3 same 5 Lots better	1 2 3 4 5
46. Why?	

47. How confident do you feel NOW regarding the management of the following?

Please tick one box for each row	Not at all confident	Not confident	Neither	Confident	Completely Confident	Not applicable
Your supply of medicines	☐	☐	☐	☐	☐	☐
Your social care issues eg cooking, mobility	☐	☐	☐	☐	☐	☐
Your health issues (e.g. What To do if your health gets worse)	☐	☐	☐	☐	☐	☐

48. Please could you describe in a couple of words how the call from the discharge advocate made you feel?

49. Is there anything else that you would like to add about your discharge?

Appendix 18: OPTIMAL Patient Questionnaire- Control Group

1. MRN	
2. Optimal Id	
3. Ward	
4. Sex	
4a. Ethnicity	
5. Age	
6. Admission Nat code	
7. Optimal Risk	
8. Date Admitted (O)	
9. Date Discharged (O)	
10. Length of Stay(O)	
11. Main Reason for Admittance (C)	
12. Main Diagnosis (Categorise) (C)	
13. Mental Health Flag (C)	
20. Number, time and date of this call	
21. Person spoken to: Carer, Patient, Kin	
21a. No of Previous admittances	

Taking You Back to Your Discharge:

22. Before you left hospital who provided you with the information related to your discharge? *(please select all that apply)*

- ☐ Doctor
- ☐ Nurse
- ☐ Pharmacist
- ☐ No one

Other (please specify)

23. Were any of your medications changed or were you given any new medications before you left hospital? YES, NO, UNSURE

24. If yes or unsure did someone counsel you about the changes or your new medications before you left hospital? *(please select all that apply)*

- ☐ Doctor
- ☐ Nurse
- ☐ Pharmacist
- ☐ No one

Other (please specify)

25. Did you receive a care plan before you left hospital? YES, NO, UNSUR

Since Leaving Hospital

26. How confident were you regarding the management of the following IMMEDIATELY after leaving hospital

Please tick one box for each row	Not at all confident	Not confident	Neither	Confident	Completely Confident	Not applicable
Your supply of medicines	☐	☐	☐	☐	☐	☐
Your social care issues	☐	☐	☐	☐	☐	☐
Your healthcare issues (e.g. What To do if your health gets worse)	☐	☐	☐	☐	☐	☐

27. Were you expecting any **FOLLOW UP** appointments after your recent discharge?	Y/N/UNSURE
28. If Y to 27: Would you mind telling me what these were?	

40. Have you made any other appointments or contacted other services yourself (Since you left hospital)? E.g. Pharmacy consultation, GP	Y/N/UNSURE
41. If Y to 40: Would you mind telling me what these were?	
42. Are you still waiting to hear about any appointments? (If N go to 11)	Y/N/UNSURE
43. If so, please could you tell me what these are?	
44. Have you been admitted to CUH before? (If N go to 14)	Y/N/UNSURE
45. How did your support during this discharge compare to your last discharge? Scale of 1-5 1 Worse 3 same 5 Lots better	1 2 3 4 5
46. Why	

47. How confident are you NOW regarding the management of the following:

Please tick one box for each row	Not at all confident	Not confident	Neither	Confident	Completely Confident	Not applicable
Your supply of medicines	☐	☐	☐	☐	☐	☐
Your social care issues	☐	☐	☐	☐	☐	☐
Your healthcare issues (e.g. What To do if your health gets worse)	☐	☐	☐	☐	☐	☐

49. Is there anything else that you would like to add about your discharge?

Appendix 19: OPTIMAL No Contact Patient Questionnaire Post Intervention

1. MRN	
2. Optimal Id	
3. Ward	
4. Sex	
4a. Ethnicity	
5. Age	
6. Admission Nat code	
7. Optimal Risk	
8. Date Admitted (O)	
9. Date Discharged (O)	
10. Length of Stay(O)	
11. Reason for Admittance (C)	
12. Main Diagnosis (Categorise) (C)	
13. Mental Health Flag (C)	
14. How was the patient? (O)	
15. Services Contacted by DA (O)	
16. Services Contacted by Patient(O)	
17. Still Waiting for Appointments? (O)	
18a. Date of first call from discharge co-ordinator	
18b. Date of last call from discharge coordinator	

19.No. of times spoken to by discharge advocate	
20.Number, time and date of this call	
21.Person spoken to: Carer, Patient, Kin	
21a. No. of previous admittances (O)	

Appendix 20: OPTIMAL No Contact Patient Questionnaire Control Group

1. MRN	
2. Optimal Id	
3. Ward	
4. Sex	
4a. Ethnicity	
5. Age	
6. Admission ICD code	
7. Optimal Risk	
8. Date Admitted (O)	
9. Date Discharged (O)	
10. Length of Stay(O)	
11. Main Reason for Admittance (C)	
12. Main Diagnosis (Categorise) (C)	
13. Mental Health Flag (C)	
20. Number, time and date of this call	
21. Person spoken to: Carer, Patient, Kin	
21a. No of Previous admittances	

Appendix 21: Physicians Ear Patient Information Leaflet

Croydon Health Services NHS
NHS Trust

Croydon Health Services NHS Trust

Croydon University Hospital

530 London Road

Croydon

CR7 7YE

Tel: 0208 401 3397

Fax: 0208 401 3372

Patient Information Sheet f (Version 1:16.5.14)

You will be given a copy of this Information Sheet

Title of Project: Validation of an electronic stethoscope.

We would like to invite you to take part n a research project. Please take time to read the following information carefully and discuss with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of this project?

Dr Y L Chang is working in collaboration with Kingston University to look at the use of a new electronic stethoscope in Paediatrics, and comparing it to the traditional method of heart examinations. The idea is that an electronic recording of the heart sounds is as effective as the ordinary stethoscope in terms of accuracy, but the new device may also offer advantages in that the heart sounds are recorded, and the recordings could be stored for another clinician to hear, as well as being transmitted remotely for expert evaluation. We are therefore asking for your help in this project by letting us take arecording of your heart sounds and analysing them later..

Why have I been chosen?

You have been chosen because **You ave an underlying heart condition and is attending the cardiac clinic or ward.**

Do I have to take part?

It is entirely up to you to decide whether or not you wish to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form, a copy of which will be given to you. If you decide to take part you are still free to withdraw from the project at any time and without giving a reason. A decision to take part or not to take part will not affect the standard of care that you receives now or in the future.

What does the study involve?

If you are happy to take part then the new device would be placed onto your chest for the capture of the heart sounds as per normal cardiac examination. You would still undergo the routine examination by the cardiologist or their team as normal. We would then compare the diagnosis that would be made using the stethoscope with the one made by the cardiologist. There is no change in your treatment Any decision to change treatment would be determined by the cardiologist with reference to their current methodology and not on the findings of the electronic stethoscope. Non identifiable patient demographics, such as weight, height and age would also be captured to aid this validation, in addition to the known cardiac problems.

What are the possible disadvantages and risks of taking part?

There is no perceived disadvantage in taking part. The only risk is a small degree of exposure of your chest whist the sound recording is made.

What are the possible benefits of taking part?

There is no perceived benefit for you taking part. The only benefit is that the information so gained may help us develop new methods to aid in the diagnosis and management of **patients in the future**

What happens if something goes wrong?

It is very unlikely that anything will go wrong. However in the unlikely event of you suffering any adverse effects as a consequence of your participation in this study, then this would be covered as per standard NHS protocols for research subjects. .

Will my taking part in this study be kept confidential?

All personal information collected in the course of the research will be anonymised and kept strictly confidential. Only the clinical investigators will have access to identifiable information. All results will be anonymous and no individual will be referred to by name.

Where is this study taking place?

This study is taking place in Kingston University, Croydon University Hospital and Royal Brompton Hospital

How has this study been designed and evaluated and who is sponsoring the study?

This is a validation of the electronic stethoscope. The study has been reviewed by Kingston University's Ethics committee.

What will happen to the recordings and data at the end of the project?

These data would be kept for the duration of the study. After the study is over, the data would be destroyed unless you have consented to donate them to either Kingston or Croydon University Hospital for educational and training purposes or for the further benefit of the NHS. In the event of such data being used, it would still be totally anonymised such that no identifiable patient detail would be available.

A copy of the audio recordings as well as the final report would be available to you at the end of the study.

Thank you for reading this. Please do not hesitate to ask one of us if you have any questions.

If you wish to discuss this further, please contact Dr John Chang on Tel 0208 401 3397 or ring Mrs Aline Cook on 0208 401 3610

Appendix 22: Physicians Ear Consent Form

Croydon Health Services NHS
NHS Trust

Croydon Health Services NHS Trust

Croydon University Hospital

530 London Road

Croydon

CR7 7YE

Tel: 0208 401 3397

Fax: 0208 401 3372

Consent form

Version 1:1

Title of project: Validation of the use of an electronic stethoscope electronic listening device.

Patient's Name:

Patient's Hospital number:

I have been read the patient information sheet, dated 18th March 2016, ver 1.1

The study has been explained to me by:

Prof/Dr/Mr/Mrs/Ms……...…

(please initial each statement if it applies to you)

I have read the Patient Information sheet ver 1.1 ☐

I have been given the opportunity to ask questions and discuss this study. ☐

I have received satisfactory answers to all my questions. ☐

I have received enough information about the study. ☐

I understand that I am free to withdraw from the study at any time, without having to give a reason for withdrawing and without affecting my current or future medical care. ☐

I consent for my heart sounds to be recorded ☐

☐

I want my data destroyed after the analysis is completed

Or

I agree for my recordings to be retained and used in the future as needed

Signed.....Date:.....….....

(NAME IN BLOCK CAPITALS).....……..

Witness's signature.....Date……...

(NAME IN BLOCK CAPITALS).....……

Appendix 23: Physicians Ear Clinical Record Form

Clinical Records Form for Physicians Ear

Consent agreed:……..Yes / No

Recordings to be retained: Yes / No

Patient hospital number……

Age:……..

Weight:……

Cardiac diagnosis:……
……
……Associated co-morbidity……
……

Recording:

Date:……

Track 1

Sound amplification setting: 1 / 2 / 3 / 4 / 5 / 6 / 7

Track 2

Sound amplification setting: 1 / 2 / 3 / 4 / 5 / 6 / 7

Track 3

Sound amplification setting: 1 / 2 / 3 / 4 / 5 / 6 / 7

Track 4

Sound amplification setting: 1 / 2 / 3 / 4 / 5 / 6 / 7

Track 5

Sound amplification setting: 1 / 2 / 3 / 4 / 5 / 6 / 7