Evaluation of past and present implementation of Telemonitoring NI: Telehealth component

(including supplement on Telecare component)

Research team members

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Executive summary

1. A novel telehealth service was introduced across Northern Ireland by all five HSC Trusts (NHSCT, SHSCT, BHSCT, WHSCT and SEHSCT) on 9 December 2011. This report addresses a recent evaluation of the service, with particular reference to four target conditions: COPD, diabetes, heart failure and hypertension. The service is provided by a private contractor TF3.
2. The research utilised a mixed methods approach, involving (i) analysis of administrative data provided by TF3, (ii) linked data on healthcare service utilisation, obtained via the Honest Broker Service (HBS), (iii) data obtained via a questionnaire survey of service users and (iv) qualitative data collected via either focus group discussions or interviews with service users, their carers and healthcare professionals (telehealth key workers, community pharmacists, GPs, hospital doctors).
3. From the initiation of the service until 29 May 2015 there were 4216 referrals to the service (3944 patients). For COPD, diabetes, heart failure and hypertension there were 1046, 825, 295 and 38 patients respectively referred to the service.
4. Uptake of telehealth was highest in the NHSCT and lowest in the BHSCT, with 1228 and 456 referrals respectively. Each of the HSC Trusts had a different focus on referrals to the telehealth service e.g. referrals for weight management were highest in the NHSCT, whereas the SEHSCT and WHSCT had high numbers of patients referred for diabetes monitoring. The highest number of referrals for COPD also came from SEHSCT.
5. The majority of patients were referred once only, with only 254 being referred more than once. Referrals covered all age groups. Patients within the youngest age group (0-19 years) were referred primarily for weight management while those in the oldest age group (80-99 years) tended to be referred for COPD and heart failure management.
6. The qualitative results showed that patients (and for the most part their carers) were overwhelmingly supportive and positive about the service, especially in relation to the reassurance (peace of mind) the ongoing monitoring provided to themselves and their carers. There was strong support from patients for continuation of the service; they indicated that their knowledge and insight of their illness improved and the service incentivised self-care.
7. Healthcare professionals were generally supportive of the service but were more guarded, calling for more evidence of effectiveness. This was particularly true for those healthcare professionals who were not directly engaged with delivery of the service.
8. The quantitative results indicated that health related quality of life and self-efficacy (ability for self-care) were at the lower end of the expected range for the target conditions suggesting the cohort of patients being managed had high morbidity.
9. There was no evidence within the dataset of any marked impact of telehealth services on hospitalisations and hospital based service usage.

10. The data indicated that mortality was lower in patients who had the service initiated compared with patients who had been referred for the service but who did not have the equipment installed, particularly within the first year after the referral date. This was most marked in the COPD and heart failure groups. Although tempting to infer that the results are indicative of the alerts generated by telehealth monitoring facilitating the early implementation of life saving interventions, it is likely that at least some of these patients did not have equipment installed because they had become morbidly unwell.
11. The main limitation of the research is that the work evaluated a service that was already established without a robust control group and largely depended on routine administrative information rather than data collected to standards generally put in place for research purposes. The study was also limited in scope, i.e. other telemonitoring services e.g. weight management were not included in the main aspects of the evaluation.
12. It is recommended that future telehealth services are taken forward within a complex intervention framework (rather than simply self-monitoring) with formal education provision on disease state, medication management, management of anxiety and depression, and self-management of symptoms and furthermore that outcomes data (for research purposes) are collected alongside the delivery of the programme, such as those needed to undertake an interrupted time series analysis. Such a programme should include strict protocols for patient selection so that only those patients who are likely to gain benefit from the service, receive the service.

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1. Background

Telehealth is the use of a variety of sensors and devices to monitor remotely (usually at home) health-related parameters in patients. This usually involves telephone or internet-based technology, to allow care providers to monitor information on patient vital signs. Deviation of the latter from the patient's norm alerts the healthcare provider to the possible need for intervention. Since the monitoring becomes routine, and since patients are empowered to be more active in their own self-care, interventions can be introduced in a timely manner, with the intent of preventing, for example, the need for the patient to seek emergency hospital care.

A number of telemonitoring research studies have been published in recent years across a range of common chronic health conditions, including hypertension (Parati *et al*., 2009), heart failure (Inglis *et al.*, 2010; Dendale *et al.,* 2012, Odeh 2105 *et al,* Steventon *et al.* 2016), respiratory conditions (asthma, COPD and cystic fibrosis; Cleland *et al.,* 2007; Jarad and Sund*,* 2011; Ryan *et al.,* 2012, Odeh *et al.* 2015, Rixon *et al.* 2015, Steventon *et al.* 2016) and diabetes (Cho *et al.,* 2009; Steventon *et al. 2014,* Steventon *et al.* 2016). Under study conditions, some very positive outcomes have been reported, such as significant decreases in mortality and hospitalisations in a heart failure group (Dendale *et al*., 2012). However, the positive results in that study (n=160 patients) were not reflected in a larger study of 1600 patients (Chaudhry *et al*., 2010). The largest randomised trial to date in the UK is the Whole System Demonstrator project. This study involved more than 6,000 patients (in Kent, Cornwall and Newham) and was completed relatively recently. Again, the results have been mixed, with a decreased incidence of hospital admissions and mortality in the 12 month follow-up period in the telemonitoring group, while the number of elective admissions, outpatient visits and emergency department visits decreased, but not to a statistically significant extent (Steventon *et al*., 2012); quality of life or psychological outcomes were not improved (Cartwright *et al*., 2013) and cost per quality adjusted life year (QALY) was similar in each group due to the higher total costs of the telemonitoring intervention (Henderson *et al.,* 2013).

The lack of consistent positive findings across published studies has slowed the uptake of what intuitively should be a beneficial approach to patient care at home. Alongside the objective data, subjective views of patients on telemonitoring have generally been positive, while healthcare professionals are more cautious in their acceptance of the approach. Typical of such findings are those in a report on patient and healthcare professional views on a heart failure telemonitoring service in Scotland. In that study, telemonitoring was popular with patients who were reassured by the ongoing surveillance, while professionals commented on increased workload, the importance of case selection and the need for adequate training of themselves and of their patients (Fairbrother *et al.,* 2013).

The Centre for Connected Health and Social Care (CCHSC) in Northern Ireland launched the Telemonitoring NI project in 2011. This continues to be implemented by all five Health and Social Care (HSC) Trusts in the province and across a range of chronic conditions. The programme was implemented as a 'natural experiment' without a formal evaluation plan, rather than as a randomised trial or other formal prospective design such as a controlled before and after study or an interrupted time series. The present project relates to an evaluation of the impact of this programme, which has

received significant attention across Europe. Telemonitoring NI is a service encompassing both telehealth and telecare programmes. These programmes are delivered by the TF3 consortium (Tunstall, Fold and S3) in collaboration with the five HSC Trusts (HSCNI), i.e. Belfast, Northern, South Eastern, Southern and Western Health and Social Care Trusts (BHSCT, NHSCT, SEHSCT, SHSCT and WHSCT). Both programmes provide remote monitoring services for patients in their homes through the use of a variety of technologies. The uptake of the services across the different HSC Trusts is driven largely by the level of engagement / interest of referring clinicians. Telehealth is provided to patients with a range of chronic conditions, e.g. diabetes and COPD, and involves the use, by the patient, of home monitoring devices, with the results of such monitoring being made available via telephone / internet connection to a triage team and/or other healthcare providers. The telehealth programme is divided into two streams: (i) Triage and (ii) Track & Trend (Figure 1). The former involves daily monitoring, with alerts being sent directly to a triage team (nurses) who decide on what action is necessary. Track & Trend monitoring, on the other hand, may be less frequent than daily. The system does not send alerts to the triage team, but instead the profiles of patient data, e.g. profile of blood sugar levels over time, are viewed directly by the healthcare professional who is responsible for the patient's care, and who can review trends within the data and make interventions as appropriate. The telecare programme uses a different approach and serves a different purpose. It involves the use of sensors placed in patients' homes to allow detection of events, such as smoke in the kitchen, front door left open or patient has had a fall. Outputs from these sensors are monitored remotely by the telecare team who can provide assistance to patients, as required, either by telephone or via the emergency services.

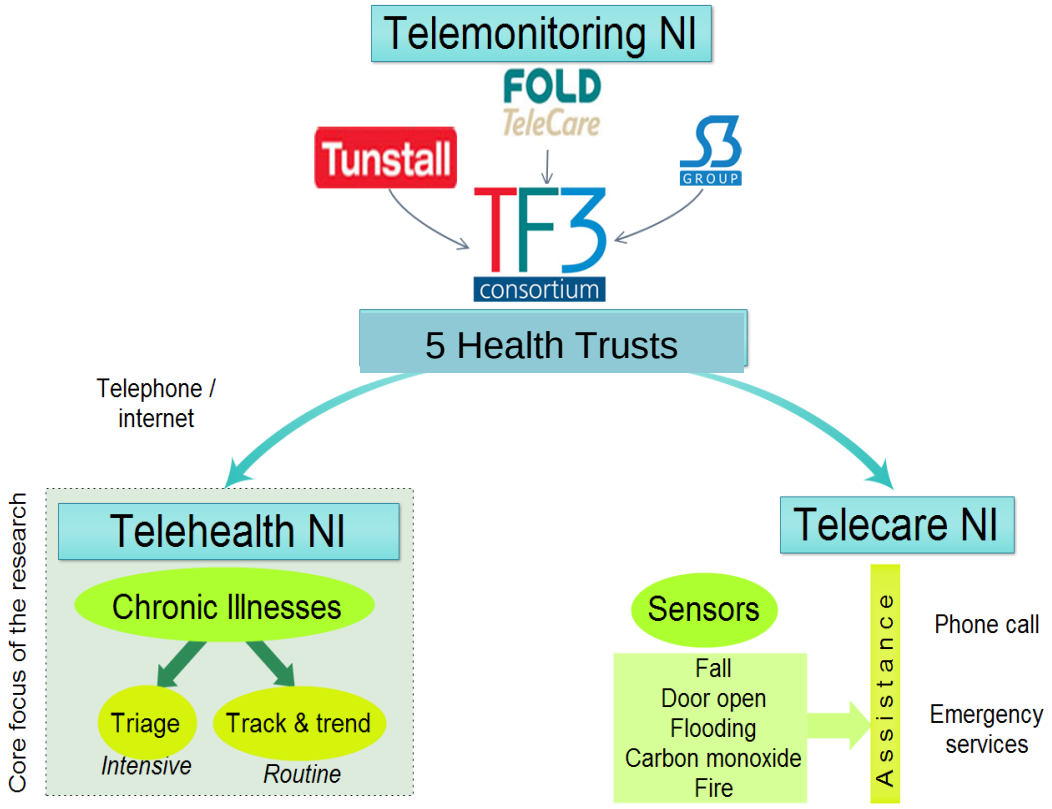


Figure 1 Diagrammatic representation of the services delivered under the Telemonitoring N. Ireland umbrella

The present evaluation involved analysis of patient data held by the service provider (TF3) and the HSC Trusts, together with additional data collected from patients and their healthcare providers (through patient completion of questionnaires; participation of patients in focus groups and of their healthcare providers in interviews regarding the value of the programme from their different perspectives). Carers also took part in this latter aspect of the work if the patient was not able to provide self-care.

Both telehealth and telecare have the aim of identifying patient problems in real time through the home deployment of monitoring devices and sensors. This remote monitoring facilitates the initiation of appropriate interventions quickly and ahead of the situation escalating. In telehealth, for example, an intervention may involve the escalation of diuretic dosage in a heart failure patient to deal with developing fluid overload and thereby prevent the need for hospitalisation. Telecare, on the other hand may involve alerting emerging health services, for example, if a patient has a fall.

The telehealth programme is the focus of the main body of this report, while the evaluation of telecare provision in Northern Ireland forms a supplement to this report. The results of the research overall will inform the process of continuous quality improvement of these remote surveillance services and inform future developments of the services.

2. Aims and objectives

The primary aims of the project were: (a) to construct a descriptive summary of the ongoing telehealth NI programme, (b) to evaluate the impact of the programme on healthcare resource usage (for example, hospitalisations) and patient self-efficacy / ability for self-care and (c) to determine the views of patients, their carers and healthcare professionals on the telehealth service.

The specific objectives were to:

1. Using routine administrative data collected by the provider (TF3) as part of the service provision, together with datasets held in the Business Services Organisation (BSO), provide a descriptive summary of the services delivered from the time of initiation of the service to the present time.
2. Through the conduct of retrospective and prospective surveys of patients who have received or are currently receiving the telehealth service, evaluate its impact on health-related quality of life and self-care (self-efficacy) for specific target conditions, i.e. heart failure, COPD, hypertension and diabetes.
3. Using data held by TF3 and the HSC Trusts, compare healthcare utilisation (hospitalisations, emergency care) by patients pre- and post-use of the service and by patients who received the service versus those who were referred to receive the service but for some reason the equipment was not installed in their home (e.g. patient declined the service or were found to be unsuitable).
4. Conduct qualitative research (focus group discussions) to gather information on the views and experiences of telehealth service users. Interviews with a number of stroke patients and their carers will form an additional group within this objective.
5. Conduct interviews with a range of healthcare professionals who are directly involved in telehealth provision (or who have the potential to be involved in the future) to gather information on their views to this new approach to community based care.
6. Conduct a health economic analysis on the telehealth programme.

3. Research overview

3.1 Permissions required

As with all research involving patients and healthcare professionals, a range of permissions were required to allow access to data, to conduct surveys and to carry out focus groups and interviews. The various permissions obtained included: ethical approval from the Office of Research Ethics Committee Northern Ireland (ORECNI), Trust governance approvals, Data Access Agreements approved by all Trust Information Governance teams, Honest Broker Service approvals and Change Control Requests (to allow data extraction from TF3 datasets). Details of these approvals are included in Appendix 1.

3.2 Study site

The evaluation involved all five HSC Trusts in Northern Ireland. There was significant variability in the ways in which the individual Trusts implemented telehealth services, their focus on different patient groups and their different alternatives to telehealth. Strong engagement and support was received from each of the Trusts, indeed telehealth service managers within each Trust acted as study Principal Investigators in delivering the research programme.

3.3 General principles of the evaluation

A mixed methods approach was used, in keeping with the resources and time available to conduct the research. Methods were chosen for their appropriateness to the over-arching aims of evaluating the impact of telehealth on patient self-care and healthcare resource utilisation. Reflecting the experience and research expertise of the team assembled to deliver this project, the focus was on four clinical conditions: heart failure, COPD, hypertension and diabetes; with a more focused, supplementary ~~a~~analysis also planned for stroke. Patients, associated carers and practitioners from each of these conditions were included in the evaluation. In order to account for differing levels of exposure to the telehealth service provision, in the quantitative analyses, patients were divided into five groupings as follows: (i) Never installed - patient was referred but equipment was not installed, (ii) Successful - patient joined service and was subsequently discharged with outcome recorded as achieved, (iii) Not successful - patient joined service, but was discharged with outcome recorded as unsuccessful, e.g. non-compliance with service, (iv) Discharged with no reason for discharge given and finally (v) Ongoing - patient joined service and continues to receive it. Further details on the criteria and definition of the five different patient groups are provided in Appendix 2.

When carrying out the questionnaire survey work to gather information of health related quality of life and self-care, two cohorts of patients were included: **Cohort 1** were patients referred to telehealth before 31 May 2015, forming a group of patients for retrospective review, and **Cohort 2** were referred to telehealth during the period June 2015 to September 2015, forming a group of patients for prospective review and follow-up. For quantitative aspects of the evaluation, anonymised routine healthcare utilisation data or administrative data already collected by the Telemonitoring NI team were used. Available data from all patients in each cohort were used in order to maximise the power of the study and to avoid problems that might arise from having to extrapolate from samples. For the qualitative and quantitative aspects that required data collection, samples were chosen relevant to the matter under investigation. An overview of the evaluation methodology is provided in Figure 2.

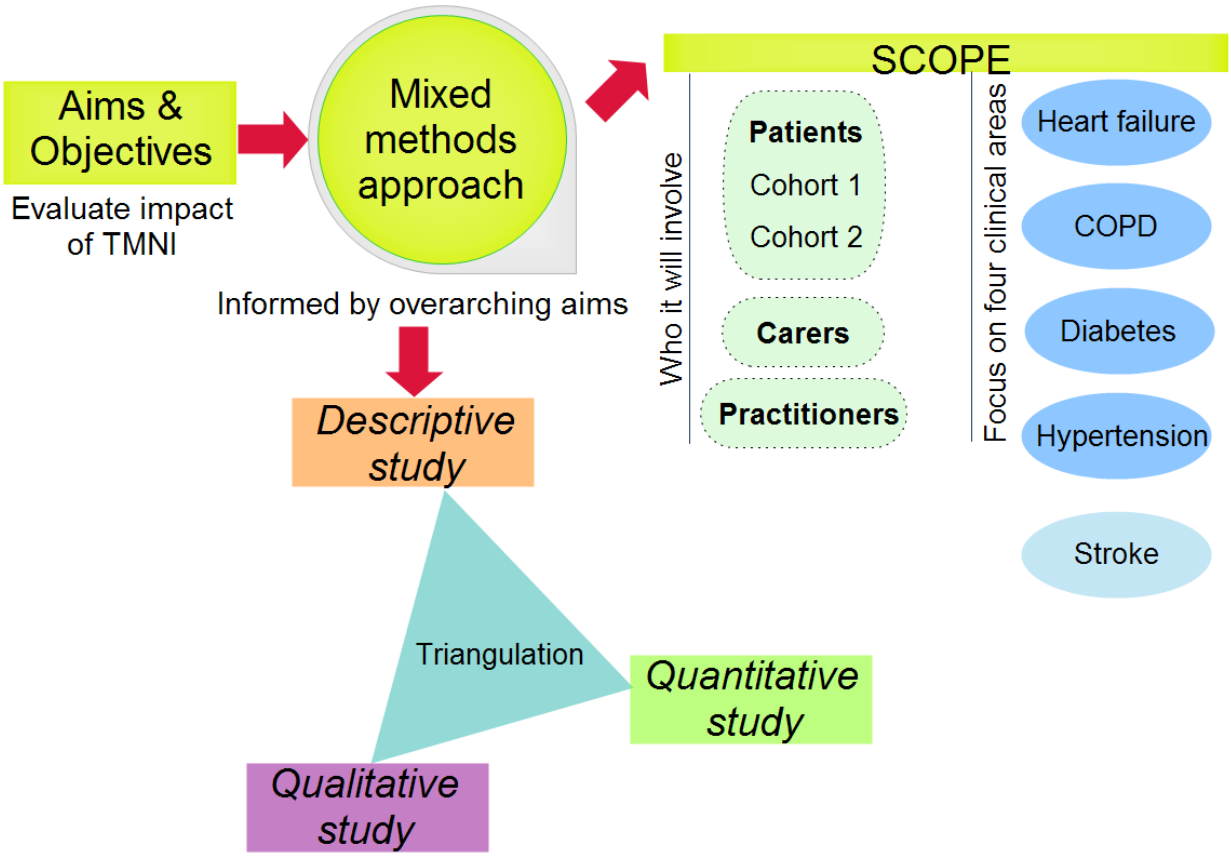


Figure 2 Schematic representation of complete study programme

4. Methodology

This section describes the series of studies that evaluated various aspects of the telehealth NI programme. These include the descriptive analyses of the uptake of the service, quantitative analyses of its effects on health-related outcomes and qualitative analyses of the views of patients, patient carers and practitioners. Results collected using the mixed methods approach outlined below were used, through a process of triangulation, to inform the conclusions drawn from the overall evaluation.

4.1 Descriptive summary of the uptake of the telehealth service

The objective of this aspect of the research was to use routine data collected by the provider (TF3) as part of the service provision, together with datasets held in the Business Services Organisation Regional Data Warehouse to provide a descriptive summary of the services delivered from the time of initiation of the service to the present time (29 May 2015). Patient-level data obtained from TF3 were anonymised by The Honest Broker Service (HBS) and made available to researchers in the HBS Research Safe Haven. The HBS provides a service which allows researchers to access healthcare data and external datasets within a secure and confidential environment (safe haven). In order to ensure confidentiality (prevent patient identification), the HBS ensures that identifiable data are not accessible to researchers and that final analyses must undergo adequate disclosure control before being released.

4.1.1 Data acquisition

Following detailed discussions with TF3 on the data held by them and following clearance by the data guardians at the five HSC Trusts, TF3 provided the following datasets to the HBS for access by the research team:

Demographic data

- Study ID (scrambled HCN; i.e. each person had one Study ID but may have multiple referrals - used for linkage purposes).
- Referral ID (unique to each referral).
- Deceased marker
- Age
- Gender
- Ethnic origin, language spoken, communication issues, mobility issues and cognitive impairment.
- Super Output Area (SOA – used to link address to measures of deprivation and in particular, urban/rural indicators)

Telemonitoring NI data

- HSC Trust
- Treatment Team
- Dates: referral, installation, discharge and removal of patient equipment
- Condition e.g. CHF, COPD, diabetes (tablet, diet and insulin controlled), gestational diabetes and a free text box to report on any other conditions, e.g. weight management.
- Disease package
- Referral priority (standard/urgent)
- Type of monitoring required (Triage or Track and Trend)
- Installed (yes/no)
- Reason for discharge
- Frequency for patient to submit readings
- Proposed length of monitoring (at time of referral, maximum length set to 364 days)
- Education package
- Additionally, smoking status, weight and fluid intake restriction details were available for some of the referrals. A scrambled GP practice code and yes/no boxes indicated which vital signs were being monitored.

The HBS also agreed to link the TF3 data with Northern Ireland Statistics and Research Agency (NISRA) deprivation data already held by them. This linkage was achieved through the use of the healthcard registration number (HCN) which is a unique identifier for all patients registered to receive national health services in Northern Ireland. The HCN was then removed from the final dataset.

4.1.2 Data analysis

The dataset used in this aspect of the research covered the period from the initiation of the service on 9 December 2011 up to 29 May 2015 (earliest and latest referral dates respectively). The dataset was used to support descriptive analyses of provision of, and engagement with, the service across the five HSC Trusts and across **all conditions** for which the service was offered. The descriptive data were categorised into quarterly (three-month) time periods from the inception of the service, to allow changes over time to be assessed.

4.2 Quantitative evaluation of the telehealth programme

The quantitative analysis aspects of the evaluation focused on three themes: (i) how engagement with the programme influenced self-care and self-efficacy, (ii) the overall effectiveness of the telehealth programme and (iii) a health economic analysis of the programme.

4.2.1 Self-care study

The focus of this evaluation was on patients who received telehealth services for the management of the four targeted conditions, i.e. COPD, diabetes, hypertension and heart failure. For this element of the research two studies were planned: a retrospective study involving Cohort 1 (patients referred for telehealth services before 31 May 2015) and a prospective study involving Cohort 2 (patients referred for telehealth services during the period June 2015 to September 2015). The questionnaires selected for both the retrospective and prospective studies were as follows:

- generic self-efficacy scale (Schwarzer and Jerusalem, 1995)
- generic quality of life questionnaire (EQ-5D-5L, Herdman *et al.,* 2011)
- COPD self-efficacy scale (Wigal *et al.,*1991)
- Stanford Self-efficacy for diabetes scale (patienteducation.stanford.edu/ research/sediabetes.pdf)
- European Heart Failure Self-Care Behaviour scale (Jaarsma *et al*., 2003)
- Hypertension Self-Care Activity Level Effects (H-Scale ; Warren-Findlow *et al.,* 2013)

All participating patients, in both the retrospective and prospective studies detailed below, were asked to complete the two generic questionnaires and the disease specific questionnaire relevant to their condition. The health-related quality of life questionnaire (EQ-5D-5L; Herdman et al., 2011) consists of a descriptive system and a visual analogue scale. Responses from the descriptive system provide a health profile of patients and can be converted into utilities by applying scores from a UK value set. The visual analogue scale records the patients' self-rated health status.

(a) Participant recruitment: Cohort 1 - retrospective study

An anonymised list of eligible patients, i.e. referred within the specified time period and receiving telehealth services for COPD, diabetes, hypertension or heart failure, were prepared by the research team in the HBS. Any record that was marked as deceased was excluded. This list was de-anonymised and passed to the service provider (Fold) by the HBS. Fold then completed a mail merge and posted information packs provided by the research team to individual patients. These packages included a letter of invitation to join the study, a participant information sheet, consent form, relevant questionnaires and a business return (postage paid) envelope. Potential participants were asked to consider taking part in the study and to return the signed consent form to the research team together with their completed questionnaires.

Initially 1000 information packs were sent out to eligible patients from Cohort 1. Due to the low numbers of patients with hypertension and CHF, all eligible patients with these conditions were sent an information pack, whereas packs were sent to a stratified random sample of patients with diabetes and COPD. Staff within Fold ensured that selected patients were eligible and had been referred for the named condition by checking against the variable "Treatment Team". This check was critical for conditions like diabetes where the patient data may suggest that they were on the service to monitor diabetes, even though, they were actually having blood sugar monitored as part of a weight management intervention. Similarly, for hypertension (which had relatively few patients), it was

important for staff at Fold to check the treatment team variable to make sure that the selected patient indeed had hypertension and was not having their blood pressure monitored for another reason.

The first 1000 packages were sent during the first week of November 2015. This coincided with a publicity piece (written story and photograph with a diabetes patient who had used the telehealth service alongside some members from the research team) to help promote this element of the study. The latter was distributed to the Press and shared on social media. By 11 December 2015 a total of 98 completed questionnaires were returned to the research team. In an attempt to increase the response rate, an additional 660 packages (to all remaining patients with diabetes and COPD) were prepared and posted by Fold. This second mailing took place during the second week of December 2015.

Following this second mailing, responses were received from a total of 120 patients. A total of 23 packages were returned to the research team indicating that the person was no longer living at the address held by Fold.

During mid-January 2016 a repeat mailing was sent to all those who had not responded, together with a copy of the Press release. Additionally, Diabetes UK NI and Chest Heart and Stroke (NI) were contacted and informed about the research. They shared the Press release on their social media outlets to help raise awareness of the evaluation. Responses were accepted until 22 February 2016 and a total of 206 responses were received by that date. Patient numbers within the full cohort, broken down by Trust are included in Table 1, i.e. the total of 1660 patients.

Table 1 Numbers of patients by Trust and condition group within Cohort 1 to whom information packs were distributed

Trust	COPD	Diabetes	CHF	Hypertension	Total
BHSCT	75	63	2	1	141
NHSCT	97	161	62	28	348
SEHSCT	200	279	24	4	507
SHSCT	137	85	90	5	317
WHSCT	92	243	7	5	347
Total	**601**	**831**	**185**	**43**	**1660**

(b) Participant recruitment: Cohort 2 - prospective study

Since the prospective aspect of this evaluation required a nine month follow-up of new patients recruited on to the service for one of the four target conditions (COPD, diabetes, hypertension or heart failure), this study was initiated ahead of the retrospective study. The recruitment strategy for identifying participants for Cohort 2 involved Fold sending out information packs to all eligible patients who were newly referred to the telehealth service during June to September 2015. Preliminary data had suggested that this would equate to 60 patients per month but, in fact, referrals to the telehealth service for the four target conditions during the recruitment period were much lower (approximately 20 per month). The plan had been to follow up these patients over a period of nine months at three month intervals (i.e. four time points; baseline, three months, six months and nine months). In addition, patients would have been asked to keep a diary of their healthcare service usage. However, due to the small number

of recruited patients (only eight consented participants), this element of the study was discontinued with the agreement of the sponsor in order to focus efforts on other elements of the research programme.

4.2.2 Effectiveness study

Data collected in the descriptive study were used within the HBS to support this aspect of the research. Additional healthcare utilisation data, held in the HBS, were also linked to patient datasets to allow a holistic evaluation of outcomes. These latter datasets were as follows:

Hospital outpatient clinic data (for each episode)-OP dataset

- Appointment date
- Reason for referral & code
- Procedure code
- Type of outpatient clinic (service description / speciality)
- Consultant-led or non-consultant-led

Accident and Emergency data (for each episode)-Symphony & NIRAES datasets

- Date of attendance at A&E
- Reason for attendance at A&E (Diagnosis code)
- Diagnosis description
- Discharge outcome/departure method

Hospital admission and discharge data including day procedures (for each episode)-A&D dataset

- Date of hospital admission
- Reason for hospital admission (Diagnosis code)
- HRG4 grouping
- Elective or non-elective
- Date of discharge from hospital
- Place discharged to

Other health and social care data (for each episode) (Enhanced Prescribing Database-EPD)

- Prescribing and dispensing data.

The original protocol for the evaluation included a plan to use linked information on all contacts with GPs and other providers of health or social care in order to provide a full 'picture' of healthcare resource utilisation, however, this level of detailed data was not consistently available at the time of the study. These analyses were therefore not incorporated into this report.

Individual patients were matched with their routine healthcare utilisation data. Associations between the provision of telehealth services and outcomes were assessed. As mentioned in Section 3.3, this involved comparing five groups of patients, classified as: (i) Never installed – patient was referred but equipment was not installed, (ii) Successful – patient joined service and was subsequently discharged with outcome recorded as achieved, (iii) Not successful – patient joined service, but was discharged with outcome recorded as unsuccessful, e.g. non-compliance with service, (iv) Discharged with no reason for discharge given and finally (v) Ongoing – patient joined the service and continues to receive it (Appendix 2).

The ***date of installation*** or in the case of those not installed, the ***date of referral*** was used as a time point to demarcate whether telehealth had a subsequent effect on healthcare service interactions. Healthcare utilisation data were available for the period 20 November 2009 until 21 December 2015. Data were computed for each patient within this timeframe for the period before the installation date and for the period after the installation date. If a patient died after installation, an estimated date of death was inserted as the endpoint for that individual. As actual date of death was not available, we used the last date on which a prescription was issued (taken from the Electronic Prescribing Database, EPD) as a proxy for the date of death. For those patients who were referred more than once (two or three times), the earliest date of referral was selected as the initiation period for telehealth service provision.

4.2.3 Statistical methods

Analyses were performed at a significance level of 0.05. Data were summarised as mean and standard deviation (SD), median and inter-quartile range or numbers and proportions (%) depending on the scale of measurement. Difference in the continuous outcomes (e.g. number of admissions, length of hospital stay) between the groups was tested for significance using the independent t-test when comparing two groups (e.g. never installed versus installed) or 1-way analysis of variance followed by post-hoc tests for 3+ groups (e.g. never installed versus not successful, successful, ongoing). The chi-square test was used to test the difference in the proportions between groups for categorical variables (e.g. mortality). Time-to-event data (e.g. time from installation to death) were analysed using Kaplan-Meier plots and the log-rank test.

4.3 Health economic analysis of the telehealth programme

The principal aims of the economic component were as follows;

1. To analyse the non-elective healthcare service costs of patients in each of the target conditions. This was completed for before and after referral to the service and for all five patient types.
2. To estimate the cost of providing the telehealth service per patient overall and per patient within each of the target conditions.

4.3.1 Costing non-elective healthcare service usage

The patient-level non-elective healthcare service use collected in the effectiveness study (see previous section) was combined with unit costs (Table 2) to estimate a cost for each patient. This was costed before and after referral to the service and for the five different patient groups. Unit costs were based on the 2013/2014 financial returns of the health and social trusts in Northern Ireland which were obtained from the Department of Health, Social Services and Public Safety. Due to the lack of reliable Health Resource Group (HRG) coding in the linked data obtained from the HBS we could not assign specific unit costs to each non-elective stay. Instead we based the unit costs on the weighted averages of the costs for each type of stay. For long stays of more than six days (weighted average length of stay of all non-elective long-stays), we attached an excess bed day cost for every day over. The unit costs for outpatient attendances and accident and emergency visits were similarly based on weighted

averages. We bore in mind the patient demographic and did not included paediatric and pregnancy related HRGs in our calculations of weighted averages.

Table 2 Unit costs (£) of non-elective hospital services.

Service	Unit costs (£)
Non-elective inpatient stay (short stay)	584
Non-elective inpatient stay (long stay)	2959
Non-elective excess bed day (long stay)	420
Outpatient attendance	154
Accident and Emergency	139

Source: Trust Financial Returns (TFR H), 2013/14.

4.3.2 Costing the telehealth service

We used the TF3 dataset which included all patients who were referred to the service from 09 December 2011 until 29 May 2015 to estimate the cost of providing the service up until a cut-off date of the end of July 2015. Information on the some of the costs associated with the delivering the telehealth service was provided by the Centre for Connected Health and Social Care (CCHSC). Four key cost components were identified;

1. Installation charge
2. De-installation (removal) charge
3. Daily disease package charge
4. Standing charge.

The fixed price to install the telehealth equipment in a patient's home was £32 and the fixed price to de-install was also £32. The daily disease package charge reflected the costs associated with maintaining the equipment and was dependent upon the disease package the patient was receiving as presented in (Appendix 7: Table 7.16).

For each patient referred to the service during the specified timeframe we calculated the cost to provide them with the telehealth service using the following formula (where y is the daily charge for the appropriate disease package as specified in Appendix 7: Table 7.16);

Installation charge (£32)	+	De-installation charge (if applicable = £32)	+	Daily standing charge (£2.28 x days on service)	+	Disease package daily charge (£y x days on service)	=	Total cost for each referral (£)

We also calculated costs on an annual basis to provide a one year snapshot of the service. We costed for the whole service as well as for the four target conditions only.

4.4 Qualitative analyses of patient and health professional views of the telehealth programme

The objectives of this aspect of the evaluation were twofold:

(a) To conduct focus group discussions with telehealth service users to obtain their views and experiences of the service. While the emphasis was on the four target conditions (COPD, heart failure, hypertension and diabetes), interviews with a number of stroke

patients, carers and patients who were offered telehealth and declined, or who were discharged unsuccessfully, were also carried.

(b) To conduct interviews with a range of healthcare professionals who are directly involved in telehealth provision (or who have the potential to be involved in the future) to gather information on their views on this new approach to community based care.

4.4.1 Patient views on the telehealth programme

The primary approach to collecting data on the views of patients about the telehealth service was via focus groups. Five focus groups incorporating the four target conditions (distributed across the five Trusts) were held. Telehealth Service Managers (TSMs) in each Trust were asked to identify patients (with COPD, heart failure, diabetes or hypertension) who would be able to travel to and take part in a focus group discussion. A study information sheet, invitation letter, consent form and stamped addressed envelope were posted to TSMs who distributed these to potential participants. If an insufficient response was received the groups were supplemented by patients from the Cohort 1 and Cohort 2 subgroups (Section 4.2.1) who had expressed an interest in taking part in focus group discussions when they returned their questionnaires.

TSMs were asked to select participants with a range of the conditions being studied, and some with multi-morbidity, in order to get a good representation of patients who have received the service.

Having recruited patients and having obtained their written informed consent to participate, focus groups were convened at a time and place convenient to participants (for example, a meeting room at a Trust hospital site). Trust TSMs assisted in finding a suitable venue. A topic guide directed discussion at the focus groups. Topics included perceived value of telehealth monitoring in self-care, educational aspects of the service, engagement with the service and healthcare providers, confidence in using equipment, user-friendliness of equipment, confidence placed on readings taken, interactions with healthcare professionals during their period of equipment use, and perceived value of participation in the programme (e.g. peace of mind through self-monitoring). Participants were encouraged to introduce other topics of interest and importance. All focus group discussions were audio recorded and participants were assured that all comments made were non-attributable (kept confidential) and that their names would not appear on any study reports.

Focus group methodology was selected in order to stimulate open conversation, allowing for the expression of ideas and common experiences which might not have been expressed in a one-to-one interview situation. It is also a more cost-effective and efficient means of assessing the views of a large number of individuals than one-to-one interviews (Hughes and McCann, 2003).

To supplement the focus group discussions, three additional groups of participant were recruited:

- Home visits were made to patients with stroke who had used the service. These patients were interviewed together with their carers (as appropriate). The same range of questions as addressed in the focus groups were used, and all recordings were transcribed in full for qualitative analysis.
- Secondly, views of patients who were offered the service and declined, or who were discharged early due to engagement issues were gathered. Patients who fitted into this category were identified

using the Telemonitoring dataset accessible via the HBS. Patient health and social care numbers were passed confidentially to Fold, who posted invitations supplied by the research team. The topic guide for these interviews included questions similar to those used for the focus groups but with additional questions designed to ascertain reasons for declining the service or being discharged early.

- Thirdly, carers of patients were interviewed to gain insight into their experiences of telehealth, with recruitment again being facilitated by the telehealth key workers.

All interviews were transcribed verbatim and two researchers conducted independent analyses of the transcripts in order to find emerging themes. A constant comparative method was used and agreement was reached between the researchers on the discovered themes.

4.4.2 Healthcare professional views on the telehealth programme

A sample of healthcare professionals, from different professional groups who were involved in the delivery of the telehealth service (triage nurses, service development managers in Trusts, telehealth NI key workers (i.e., specialist community nurses) or who had the potential to be involved in the future (general practitioners, community pharmacists, hospital doctors) were recruited to take part in telephone interviews. As with recruitment of patients to focus groups, the research team sought the help of TSMs with this task. Snowball sampling was also employed in order to optimise the number of participants available for interview.

Telephone interviews covered a similar range of topics to those in the focus group discussions with patients and were continued until data saturation was reached for each healthcare professional grouping. If healthcare professionals were not currently involved in telehealth delivery they were asked from the perspective of their potential engagement with the service. All interviews were recorded and transcribed for analysis. A similar analytical approach was employed to that used for the patient focus groups.

5. Results

The results of the different aspects of the evaluation are presented in the same sequence as used in the methodology section, as follows:

5.1 Descriptive summary of the uptake of the telehealth service

5.2 Quantitative evaluation of the telehealth programme

- 5.2.1 Self-care study
- 5.2.2 Effectiveness study

5.3 Health economic analysis of the telehealth programme

5.4 Qualitative analysis of patient and healthcare professional views of the telehealth programme

- 5.4.1 Patients views on the telehealth programme: focus groups
- 5.4.2 Patients views on the telehealth programme: carers
- 5.4.3 Patient views of telehealth programme: patients discharged unsuccessfully
- 5.4.4 Healthcare professional views of the telehealth programme

5.1 Descriptive summary of the uptake of the telehealth service

This section provides a descriptive overview of all those referred to the telehealth service, **for all conditions** (i.e. not restricted to the four conditions that form the focus of other aspects of this evaluation). Data are reported at the level of individual patients as far as possible, but where appropriate, data are presented on a referral basis (bearing in mind that some patients were referred more than once). There were a total of 4216 referrals to the service over the time period covered by the evaluation which equates to 3944 individual patients (Table 3). Of those who were referred to the service, 695 people (17.6%) were recorded as deceased. Exemplars of the main findings are included within the body of this report while several supporting or supplementary tables are included in Appendix 4.

5.1.1 Timeframes and patient numbers

Table 3 General characteristics of total dataset (timeframes and referral numbers)

Procedure	Earliest	Latest	Notes
Referrals	09 Dec 2011	29 May 2015	All 4216 have a referral date. 408 referrals were not installed.
Installation	12 Dec 2011	28 May 2015	3808 have an installation date. 2778 have an installation and discharge date. 1030 installed referrals are still on the service (no discharge date).
Discharge	21 Dec 2011	09 Oct 2015	2778 have a discharge date. 92 of which have been discharged but equipment has not been removed (timeframe for discharge dates: 9 March 12 to 9 October 2015).
Removal	11 Jan 2012	24 Sept 2015	2692 have a removal date. Of the 92 with no removal date: 27 are deceased. Reasons for discharge of the 86 (other than deceased) are: patient declined service, non-compliance, inappropriate referral, new referral required, outcomes achieved, not and partially achieved and patient left Trust area.

5.1.2 Demographic information

Age: patients ranged from 4 to 99 years of age, with a mean of 57.6, (standard deviation: 19.8) and median of 63 years.

Table 4 Age distribution of participating patients

Age group	n	%	Cumulative %
0-19	110	2.8	2.8
20-29	357	9.1	11.8
30-39	465	11.8	23.6
40-49	334	8.5	32.1
50-59	493	12.5	44.6
60-69	842	21.3	65.9
70-79	893	22.6	88.6
80-84	280	7.1	95.7
85+	170	4.3	100.0
Total	3944	100.0	

Gender: More females (2294 or 58.2%) than males (1650 or 41.8%) have been enrolled in the telehealth service.

Ethnicity: Most patients were Caucasian (3859), 56 have no ethnicity stated and 29 come from other ethnic backgrounds, which include: Asian (Chinese, Indian, Philippine, Other); Black (African, Caribbean); Travelling community; Mixed (Asian/ Black: African/ Caucasian), Portuguese and Romanian.

Language: Most patients (3922) had English as their first language, with only 22 reported to speak other languages, which include: Chinese, Czech, Latvian, Hindi, Lithuanian, Polish, Portuguese, Romanian, Slovakian, Somalian and Tetum.

Communication issues: Most referrals (4055) were reported to have no communication issues. The remaining 161 referrals had some form of communication problem, described within the following areas: understanding of equipment; hearing, visual or speech impairment; uses lip reading, interpreter, Braille or sign language; becomes anxious; becomes breathless; needs assistance (family member will communicate with telehealth team); dementia, stroke, Parkinson's and Down's syndrome; English is not their first language.

Cognitive impairments: Most patients (3861) using the telehealth service were reported not to have any cognitive impairment. However, 61 were classified as having a mild cognitive impairment and 22 as having a moderate or severe cognitive impairment.

Physical impairments: Most patients (3044) did not have a recorded physical impairment. However, 610 were mobile with aids (including wheelchair users), 203 were reported to be mobile at home only and 45 were recorded as having no mobility. The remaining 42 had some other mobility issue recorded, for instance, back/knee/feet problems, prosthetic leg, paralysis of one side of body, uses ambulatory oxygen, osteomyelitis (foot), slow movement, bed bound and visual impairment which restricts mobility.

5.1.3 Referral and service provision

Referring Trusts: Referral numbers by Trust (from highest to lowest) are ordered as follows: NHSCT (1228 referrals), SHSCT (968), WHSCT (834), SEHSCT (730) and finally BHSCT (456).

Multiple referrals: Most patients (3691) were referred once only, 235 were referred twice (470 referrals) and 18 were referred three times (54 referrals).

Conditions referred for, including co-morbidities: Patients were predominantly referred for the following single conditions, i.e. COPD, diabetes, weight management, stroke, heart failure and kidney problems. Other conditions included co-morbidities, such as diabetes with weight management, CHF with COPD, COPD with other comorbidities and hypertension only (Figure 3).

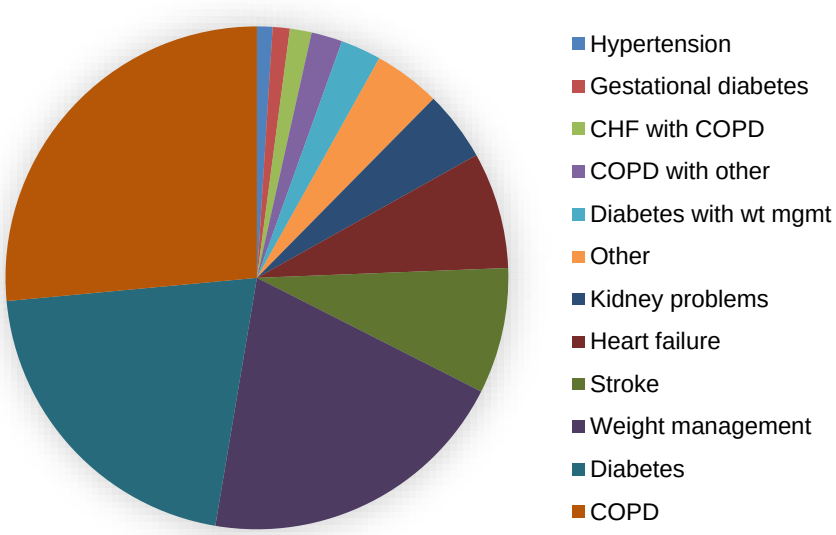


Figure 3 Conditions for which patients were referred to the telehealth service

Disease packages: The most common disease packages that patients were supplied with included: diabetes home based (1395), COPD (976), diabetes mobile (562), stroke (371), heart failure (325) and COPD with BP (290). It should be noted that many patients who were supplied with a diabetes package were receiving this for weight management.

Education packages: Most patients (3826) using the telehealth service were reported as not having been given any education package. Some examples of education packages which were recorded as delivered were in relation to diet, exercise, weight management, management of COPD, management of diabetes, management of heart failure, secondary prevention of stroke and inhaler technique.

Referral priority: Most referrals (3815 or 90.5%) were classified as 'standard' referrals, with 401 (9.5%) classified as 'urgent' referrals. There were 408 referrals that were not installed.

Proposed and actual length of monitoring: The 'proposed length of monitoring' is set at the time of referral with the maximum length restricted to 364 days. Many referrals were renewed, which accounts for the longer upper limit within duration of monitoring in the variable 'actual length of monitoring'. The 'proposed length of monitoring' variable ranged from 7 to 364 days (median 182 days) while the actual length of monitoring ranged from 0 to 1387 days (median 161.5 days). 1030 referrals had no 'actual length of monitoring' recorded, since this sample included patients who were still on the service and have not yet been discharged.

Quarterly uptake of service: There was a slightly higher number of installations during the second quarter after initiation of the service (January to March 2012, 426 installations), than in any other quarter (see Appendix 4: Tables 4.7-4.9 for more detail).

Frequency of patient submission of data: Most referrals (1819) involved patients submitting data on a weekly basis; 1092 were recorded as submitting data daily, with 927 on weekdays only and the remaining 378 submitting data at another frequency (including weekends; Appendix 4: Table 4.10).

Patient types: For the purposes of the quantitative study (Section 4.2), patients were categorised into patient types. The composition of the full dataset of 3944 people were as follows: non-target condition (1549), ongoing (736), discharged - successful (571), mixed or other (436), discharged with reason for discharge unknown (289), discharged - not successful (249) and never installed (114).

Type of monitoring required: 1671 referrals were for the triage service and 2545 for the track and trend service. The majority of those with diabetes and hypertension were referred for track and trend monitoring, whereas the majority of COPD and heart failure patients were referred for the triage service (Table 5).

Table 5 Type of monitoring required for the four main target conditions

Condition	Track and trend (total referrals)	Triage (total referrals)
COPD	19	904
Diabetes	754	26
Heart failure	11	273
Hypertension	39	4

5.1.4 Patient deprivation and proximity to services

The 2011 Super Output Areas (SOAs) were used to examine the distribution of the addresses of telehealth service users in accordance with deprivation indices. In particular the Multiple Deprivation Measure (MDM) and the proximity to services subscale within this latter measure were referenced. A total of 4171 out of the 4216 referrals had an address associated with them. If an even distribution was present, there should be equal distribution across all ten deciles on each of the scales. The results obtained (Figure 4) indicate that there was an under-representation of patients from the least deprived deciles for both scales (MDM and proximity to services subscale).

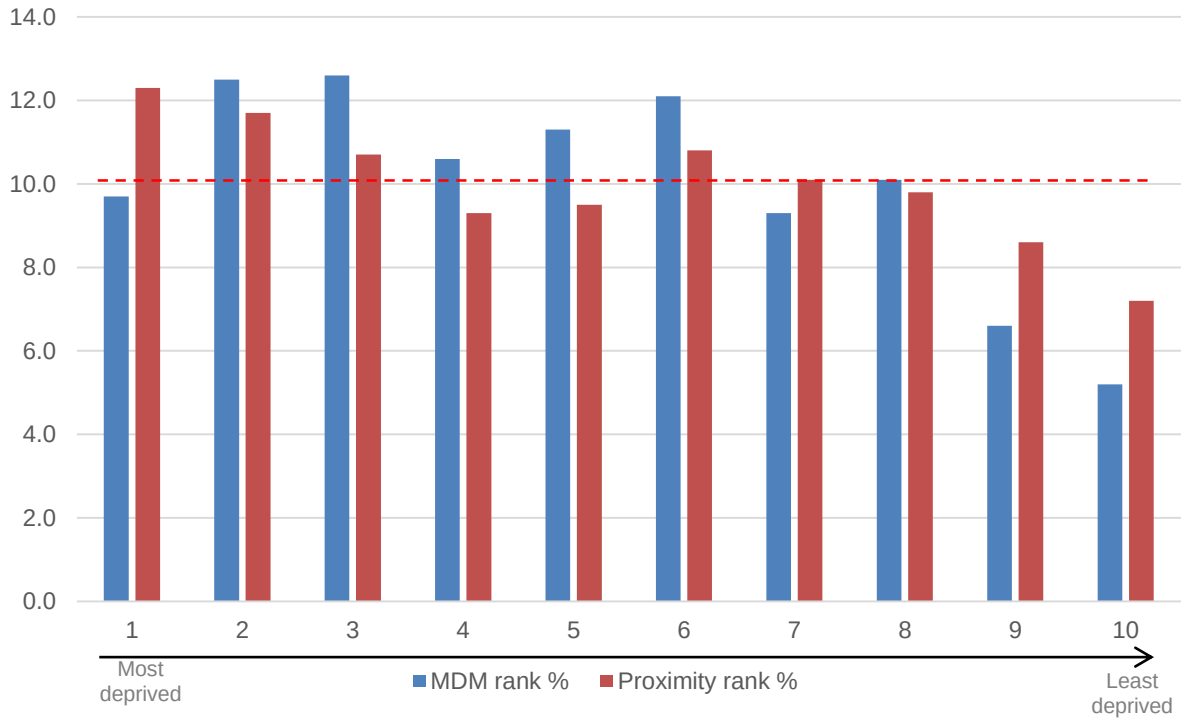


Figure 4 Distribution of patient deprivation in terms of overall MDM rank and proximity to services subscale.

5.1.5 Relationships between variables

A number of cross tabulations were performed in order to characterise the distribution of the services across the different Trusts and patient groupings. Exemplars of the findings are presented below, with further detail presented in Appendix 4: Tables 4.20-4.24. The Y-axis in all graphs presented below is number of individual patients.

Age group by Trust

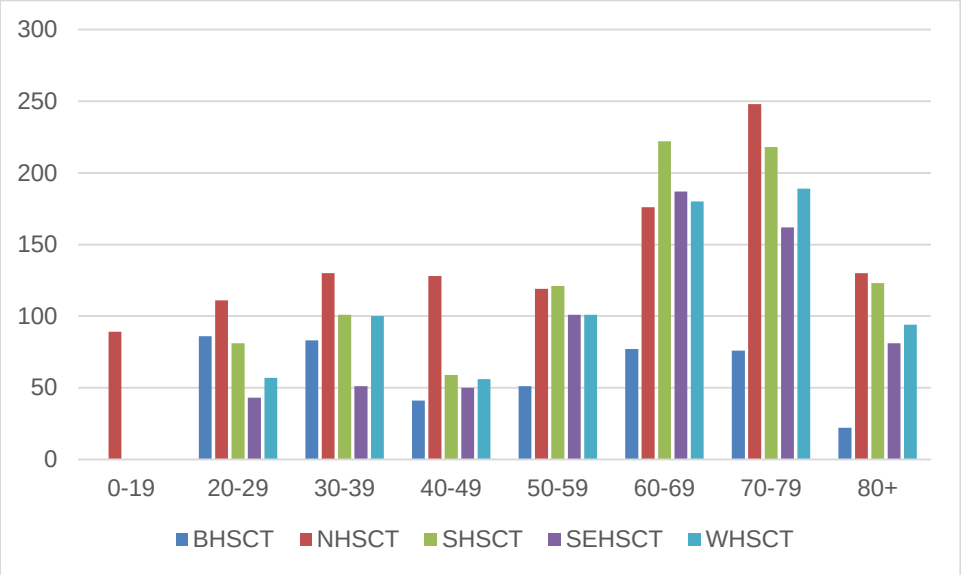


Figure 5 Age groups of patients to the telehealth service by Trust

Figure 5 highlights the differing levels of patient participation across the different HSC Trusts. A notable outlier is referrals of patients in the age category 0-19 years by the NHSCT. This is due to their significant adoption of the service for weight management for younger patients (often a service which is given to a whole family).

Conditions by age group

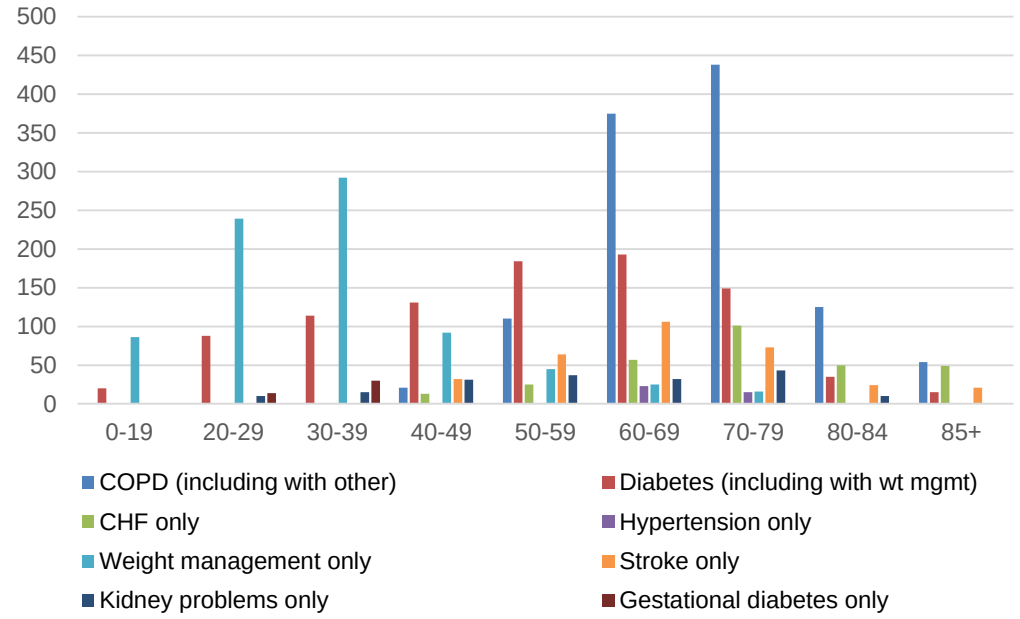


Figure 6 Conditions of patients who were managed via the telehealth service by age group

Conditions which appear in the younger age groups largely involve weight management and diabetes. All the gestational diabetes referrals were in the age group of 20-49 years. Conditions including COPD, heart failure and stroke appear more frequently in the older age groups, in keeping with general population statistics.

Conditions by Trust

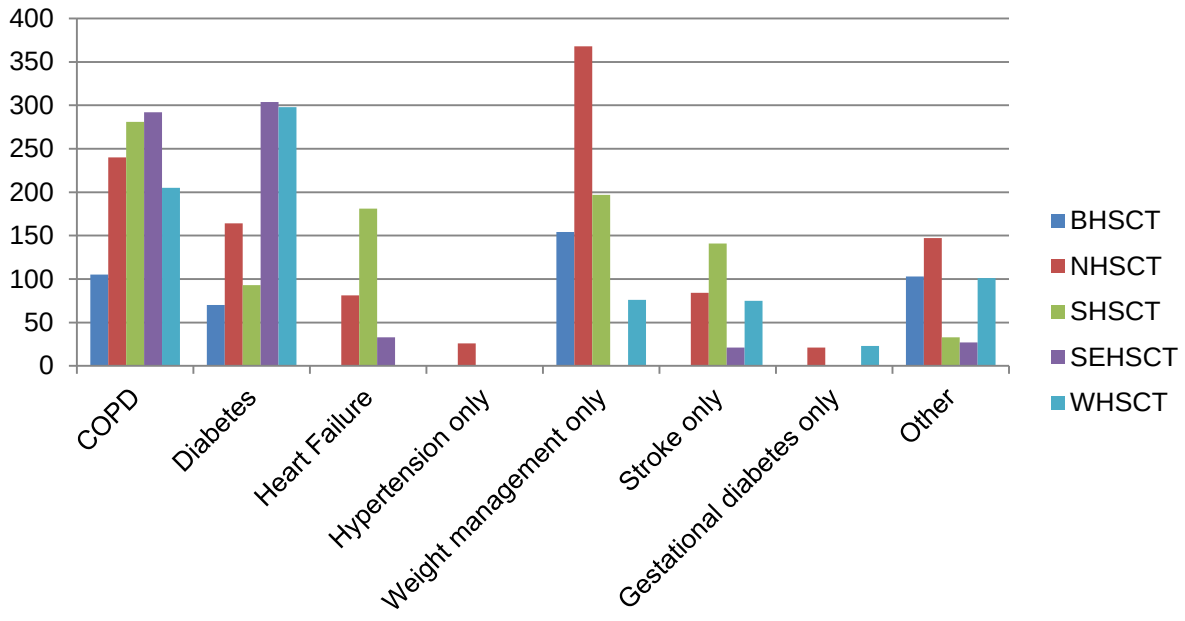


Figure 7 Conditions for which patients were being monitored via the telehealth service by Trust

Although NHSCT had the highest number of patients overall, the numbers are lower for the target conditions for this study. NHSCT had the highest number of referrals for weight management. SEHSCT and WHSCT had high referrals for COPD and diabetes. SHSCT and NHSCT had higher referrals for heart failure and hypertension, respectively.

Conditions by gender

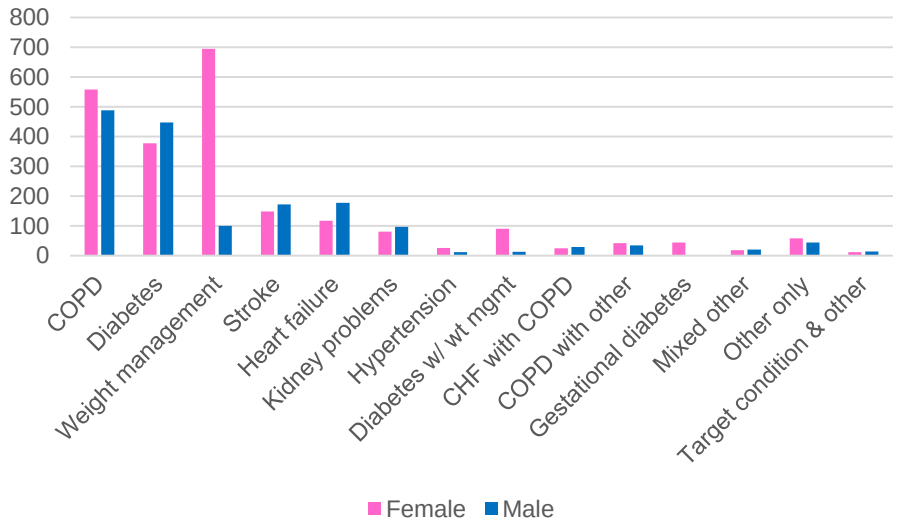


Figure 8 Conditions for which patients were monitored via the telehealth service by gender

Overall, as noted above more females than males were referred to the service. This was particularly the case for weight management. However, there were some conditions for which more males were referred, i.e. stroke, heart failure and kidney problems.

Age group by gender

The excess of female referrals compared to males is in large part due to their much higher referral in the younger age groups, which is associated with the monitoring of conditions such as weight management and gestational diabetes.

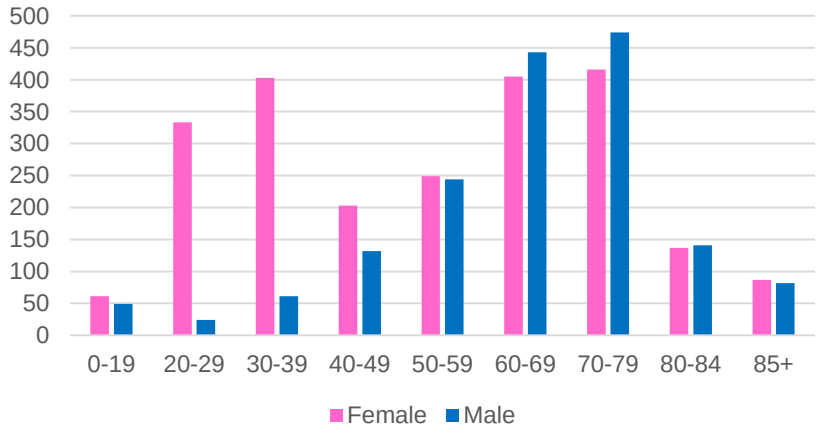


Figure 9 Distribution of patient age groups by gender

5.2 Quantitative evaluation of the telehealth programme

As detailed within the methodology section, the quantitative evaluation of the telehealth programme involved two distinctive studies, the self-care study (retrospective survey of patients receiving services for one of the four target conditions) and an effectiveness study in which data for all patients who received the telehealth service for the targeted conditions were linked with healthcare utilisation data within the HBS. The results obtained using these two separate approaches are presented in this section.

5.2.1 Self-care study

A total of 206 patients who received telehealth services for the targeted conditions completed the study questionnaires. The number of participants by disease category (Table 6) were as follows: 94 (46%) COPD; 67 (33%) diabetes mellitus; 32 (16%) heart failure (HF), and 13 (6%) hypertension (HTN). Further details are included in Appendix 5.

Table 6 Distribution of respondents by health condition

Clinical condition	COPD	Diabetes mellitus	Hypertension	Heart failure	Total
Number of respondents	94	67	13	32	206
Surveyed patients	601	831	43	185	1660
Response rate (%)	15.6	8.1	30.2	17.3	12.4

All patients were asked to complete the same set of generic self-efficacy and generic health-related quality of life questionnaires, i.e. General Self Efficacy (GSE), European Quality of Life - Visual Analogue Scale (EQ VAS) and the European Quality of Life Index (EQ-Index) questionnaires. The mean scores are presented in Table 7. In general, patients with COPD and HF reported lower scores (poorer health-related quality of life and self-efficacy) compared to patients with DM and HTN.

Table 7 Participant scores (mean ± SD) for GSE, EQ VAS and EQ-5D-5L across the different health conditions

Outcome measure	COPD (n=94)	Diabetes Mellitus (n=67)	Heart Failure (n=32)	Hypertension (n=13)	Total (n=206)
GSE score [a]	2.7 ± 0.7	3.0 ± 0.7	2.7 ± 0.9	3.1 ± 0.8	2.8 ± 0.7
EQ VAS[b]	49.2 ± 21.0	60.6 ± 23.4	52.1 ± 20.5	69.6 ± 26.2	54.6 ± 22.8
EQ -5D-5L Index[c]	0.353 ± 0.304	0.534 ± 0.348	0.433 ± 0.323	0.689 ± 0.365	0.445 ± 0.338

[a] GSE: General Self Efficacy - score range is from 1 to 4. Higher number indicates higher self-efficacy.
[b] EQ VAS: European Quality of Life questionnaire - Visual Analogue Scale: This scale ranges from 0 to 100. 100 means the best health you can imagine. 0 means the worst health you can imagine.
[c] EQ-5D-5L Index: European Quality of Life questionnaire; Score range is from -0.594 to 1. 1 means the best health you can imagine.
Literature values for other study populations are presented in Appendix 5

A further breakdown of the summary data presented in Table 6 for the EQ-5D-5L was performed to allow consideration of the problems being encountered by the different patient groups. These data, broken down by dimension, are presented in Table 8. Approximately of 50% of all COPD and HF patients reported moderate or severe problems on each dimension. The degree of problems experienced by hypertension and diabetes patients were less severe.

Table 8 Frequency of reported problems by dimension of the EQ-5D-5L by patients in the different target disease groups

EQ-5D-5L Dimension		COPD n (%)	DM n (%)	HTN n (%)	HF n (%)	Total n (%)
Mobility	Level 1 (no problem walking)	5 (5.3)	19 (28.4)	7 (58.3)	5 (15.6)	36 (17.6)
	Level 2 (slight problem walking)	11 (11.7)	10 (14.9)	2 (16.7)	5 (15.6)	28 (13.7)
	Level 3 (moderate problem walking)	30 (31.9)	14 (20.9)	1 (8.3)	12 (37.5)	57 (27.8)
	Level 4 (severe problem walking)	42 (44.7)	22 (32.8)	2 (16.7)	8 (25)	74 (36.1)
	Level 5 (unable to walk)	6 (6.4)	2 (3.0)	0 (0.0)	2 (6.25)	10 (4.9)
Self-care	Level 1 (no problem washing / dressing)	20 (21.3)	37 (55.2)	9 (75.0)	9 (28.1)	75 (36.6)
	Level 2 (slight problem washing / dressing)	15 (16.0)	9 (13.4)	1 (8.3)	10 (31.3)	35 (17.1)
	Level 3 (moderate problem washing / dressing)	34 (36.2)	14 (20.9)	1 (8.3)	8 (25.0)	57 (27.8)
	Level 4 (severe problem washing / dressing)	20 (21.3)	6 (9.0)	1 (8.3)	3 (9.4)	30 (14.6)
	Level 5 (unable to wash / dress)	5 (5.3)	1 (1.5)	0 (0.0)	2 (6.3)	8 (3.9)
Usual activity	Level 1 (no problem doing usual activities)	7 (7.5)	22 (32.8)	8 (66.7)	3 (9.4)	40 (19.5)
	Level 2 (slight problem doing usual activities)	10 (10.8)	14 (20.9)	1 (8.3)	6 (18.8)	31 (15.1)
	Level 3 (moderate problem doing usual activities)	22 (23.7)	12 (17.9)	0 (0.0)	13 (40.6)	47 (22.9)
	Level 4 (severe problem doing usual activities)	31 (33.3)	15 (22.4)	3 (25.0)	4 (12.5)	53 (25.9)
	Level 5 (unable to do usual activities)	23 (24.7)	4 (6.0)	0 (0.0)	6 (18.8)	33 (16.1)
Pain/Discomfort	Level 1 (no pain)	10 (10.8)	14 (21.2)	4 (33.3)	3 (9.4)	31 (15.1)
	Level 2 (slight pain)	26 (28)	14 (21.2)	3 (25)	10 (31.3)	53 (25.9)
	Level 3 (moderate pain)	29 (31.2)	20 (30.3)	3 (25)	9 (28.1)	61 (29.8)
	Level 4 (severe pain)	23 (24.7)	12 (18.2)	1 (8.3)	9 (28.1)	45 (22.0)
	Level 5 (extreme pain)	5 (5.4)	6 (9.1)	1 (8.3)	1 (3.1)	13 (6.3)
Anxiety/Depression	Level 1 (not anxious or depressed)	23 (24.7)	30 (44.8)	8 (66.7)	11 (34.4)	72 (35.1)
	Level 2 (slightly anxious or depressed)	19 (20.4)	15 (22.4)	1 (8.3)	11 (34.4)	46 (22.4)
	Level 3 (moderately anxious or depressed)	33 (35.5)	15 (22.4)	2 (16.7)	7 (21.9)	57 (27.8)
	Level 4 (severely anxious or depressed)	14 (15.1)	5 (7.5)	0 (0.0)	2 (6.3)	21 (10.2)
	Level 5 (extremely anxious or depressed)	4 (4.3)	2 (3.0)	1 (8.3)	1 (3.1)	8 (3.9)

In addition to the generic questionnaires, patients were asked to complete one disease specific self-efficacy / self-care questionnaire which was specific to the condition for which they were receiving telehealth services. The questionnaires used were as follows: the COPD self-efficacy scale, the Stanford self-efficacy for diabetes scale, the European Heart Failure self-care behavior scale and the Hypertension self-care activity level effects questionnaire (H-scale). Data obtained for COPD, DM, and HF patients are presented in Table 9 while data obtained for the H-scale are presented in Table 10.

Table 9 Participant scores (mean ± SD) obtained for the COPD self-efficacy scale, Stanford self-efficacy for diabetes scale, and The European Heart Failure self-care behaviour scale

	COPD self-efficacy[a] (n=94)	**Self-efficacy for diabetes [b] (n=67)**	**The European Heart Failure self-care behaviour scale[c] (n=32)**
Mean ± SD	3.7 ± 0.9	6.9 ± 1.9	25.8 ± 8.9
Percentage of maximal score achievable (%)	74%	69%	43%

[a] Achievable score is from1 to 5; higher score indicates higher self-efficacy.
[b] Achievable score is from 1 to 10; higher score indicates higher self-efficacy.
[c] Achievable score is from 12 to 60; lower score indicates higher self-efficacy.

The H-scale measures level of adherence with a range of self-care activities in patients with hypertension. The frequency of adherence reported by the participating hypertensive patients (n-13) is presented in Table 10. Most patients reported adherence to medication usage (12 out of 13), not smoking (11 out of 13) and alcohol intake advice (10 out of 13). Only two patients reported adherence to a low salt diet (2 out of 13) and weight management recommendations (2 out of 13) while 4 patients reported adhering to recommended physical activity (4 out of 13).

Table 10 Frequency of reported adherence by hypertensive patients by dimension using H-scale

Dimension	**Patient adherence as measured by scale (n)**
Medication usage	12
DASH-Q (low salt diet)	2
Physical activity	4
Smoking	11
Weight management	2
Alcohol intake	10

Table 11 compares the GSE score, EQ VAS, and EQ-5D-5L Index between "Not successful", "Successful", "Discharged" and "Ongoing" groups. In general, the scores were similar across the different groups.

Table 11: Frequency of reported problems by dimension

Outcome measure (mean ± SD)	Never installed (n<10) We agreed to remove this group	Not successful (n=10)	Successful (n=52)	Discharged (n=17)	Ongoing (n=108)
GSE score [a]	3.0 ± 0.8	2.8 ± 0.8	2.8 ± 0.7	2.8 ± 0.7	2.8 ± 0.7
EQ VAS [b]	70.0 ± 8.2	57.0 ± 26.9	56.9 ± 23.3	52.9 ± 24.0	51.6 ± 22.1
EQ-5D-5L Index [c]	0.6 ± 0.3	0.5 ± 0.5	0.5 ± 0.3	0.4 ± 0.3	0.4 ± 0.3

[a] GSE: General Self Efficacy; mean score is from 1 to 4. Higher number indicates higher self-efficacy.
[b] EQ VAS: European Quality of Life questionnaire - Visual Analogue Scale; This scale is numbered from 0 to 100. 100 means the best health you can imagine. 0 means the worst health you can imagine.
[c] EQ-5DL-5L Index: European Quality of Life questionnaire; Score is from 1 to -0.594. 1 means the best health.

5.2.2 Effectiveness study

The complete cohorts of patients who had received / continued to receive telehealth services for the four targeted conditions (COPD, heart failure, diabetes and hypertension), giving a total sample size of 1959 patients, were included in this aspect of the research programme. A range of the summary findings (all presented as annualised data) are presented in the main body of the text, with additional supporting data summarised in Appendix 6. If a patient had mixed conditions highlighted on their referral form, e.g. heart failure and COPD, these were included in each of the condition categories for this aspect of reporting This involves 54 patients out of a total of 1959 (i.e. 2.7% of overall population).

The total population was divided into groupings as described in Section 3.3, i.e. (i) Never installed – patient was referred but equipment was not installed, (ii) Successful – patient joined service and was subsequently discharged with outcome recorded as achieved, (iii) Not successful – patient joined service, but was discharged with outcome recorded as unsuccessful, e.g. non-compliance with service, (iv) Discharged with no reason for discharge given and finally (v) Ongoing – patient joined the service and continues to receive it; and by target condition as outlined in Table 12. The telehealth referral date and date of telehealth installation were used as index dates for 'Never installed' and 'Installed' groups respectively. A new group (vi) was added for comparative purposes. This comprised those patients who had used telehealth at some stage during the period, i.e. the sum of (ii), (iii), (iv) and (v), with the numbers of patients involved also included in Table 12. These subdivisions allowed various scenarios to be compared statistically before and after patients are first introduced to the service. If a patient had multiple sessions of telehealth service provision, the date of the first installation was used as the cut point. The hypertension group had very low numbers in total, with a number of the sub-groupings having fewer than ten patients which makes their mean estimates unreliable. In the absence of a randomised control group, or some other prospectively

collected comparable group, the never installed group acted as a quasi-control group in all datasets. In some of the analyses, the successful and ongoing groups were combined since these patients were the most likely to exhibit a positive impact of the telehealth provision.

Table 12 Numbers of patients within each of the groups used in the before and after analyses

Group*	Group descriptor*	HF	COPD	DM	HTN	Total
(i)	Never installed (n)	20	46	49	4	114
(ii)	Successful (n)	106	188	283	16	571
(iii)	Not successful (n)	30	93	128	4	249
(iv)	Discharged (n)	36	130	133	3	289
(v)	Ongoing (n)	93	466	187	16	736
(vi)	Installed (n)	265	877	731	39	1845

* See paragraph above for explanation of groupings

(a) Mortality

Approximately 18% of the patients who received or were scheduled to receive telehealth monitoring for one of the four targeted conditions died during the follow-up period. There was a marked difference in mortality rates between the 'Never installed' group and patients who had telehealth services put in place (33.3% versus 13.9%; Figure 10). A Kaplan-Meier plot (Figure 11) indicated that mortality was particularly marked in the not installed group in the first year after the referral date. This means that the mortality results need to be interpreted with caution when the 'Never installed' group is used as the quasi-control group since some deaths occurred so soon after the referral date and are unlikely to have been prevented by the installation and use of the telehealth equipment. When considered by condition (Figure 12), mortality was the highest for COPD and heart failure. There were no deaths in the first two years in the hypertension group.

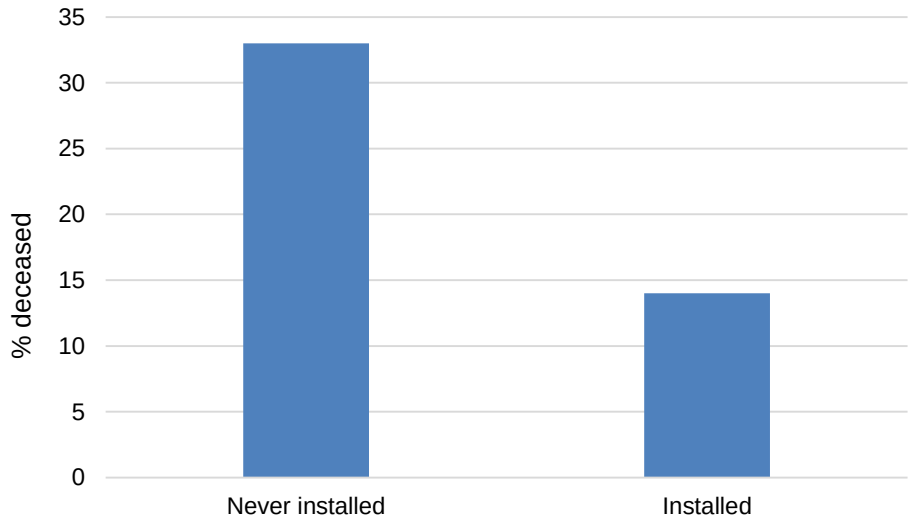


Figure 10 Comparison of mortality rates in patients who had equipment installed versus those not installed

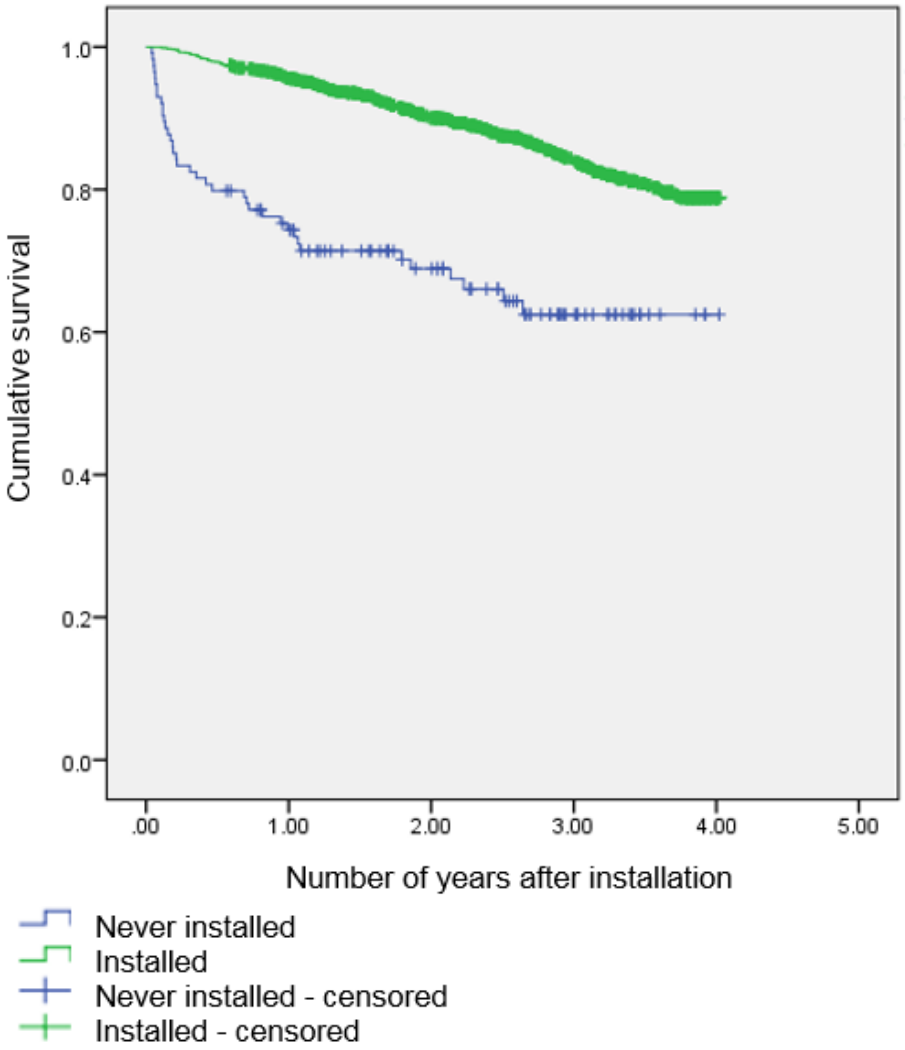


Figure 11 Kaplan-Meier survival plot comparing the never installed versus installed groups

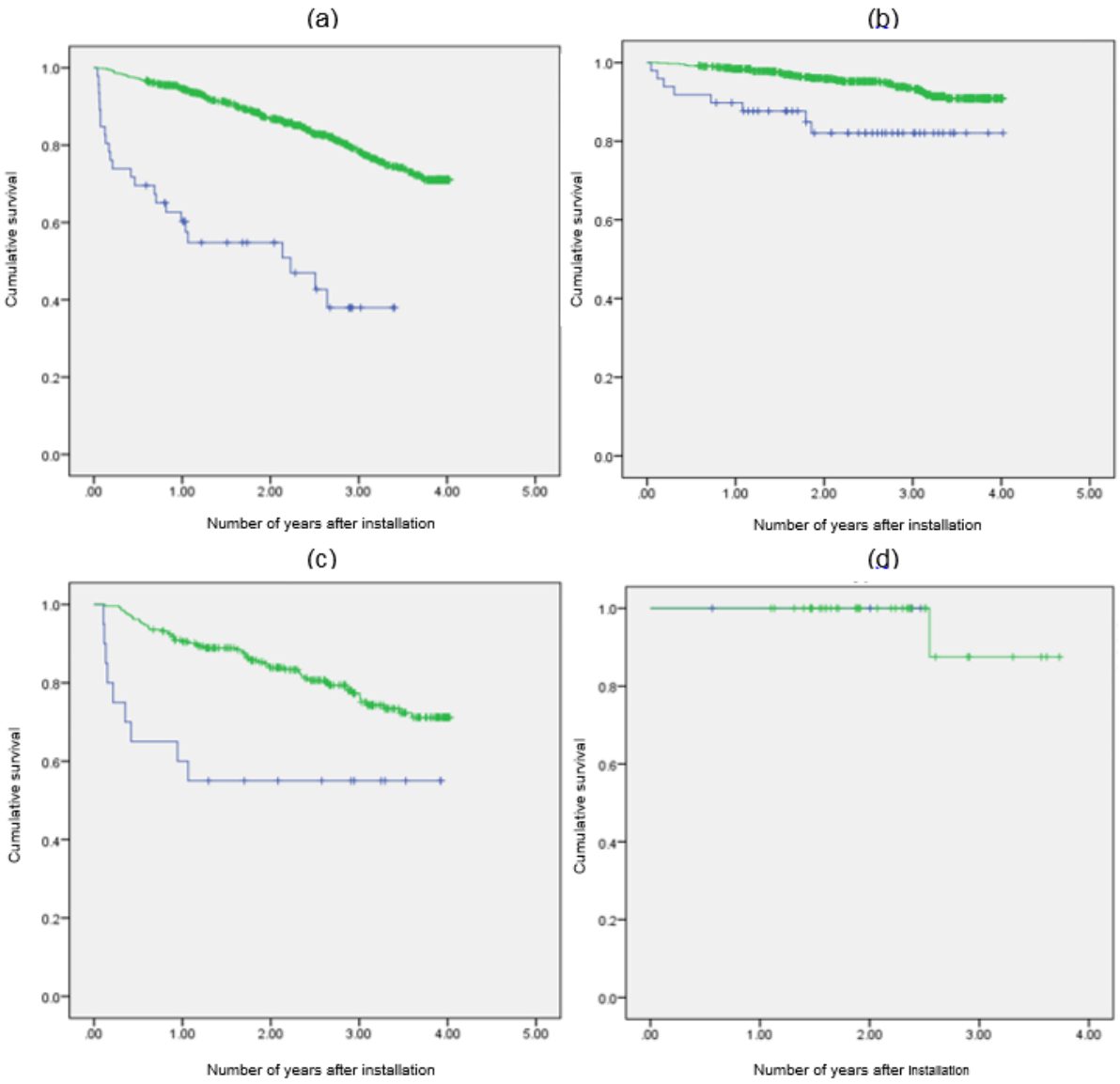


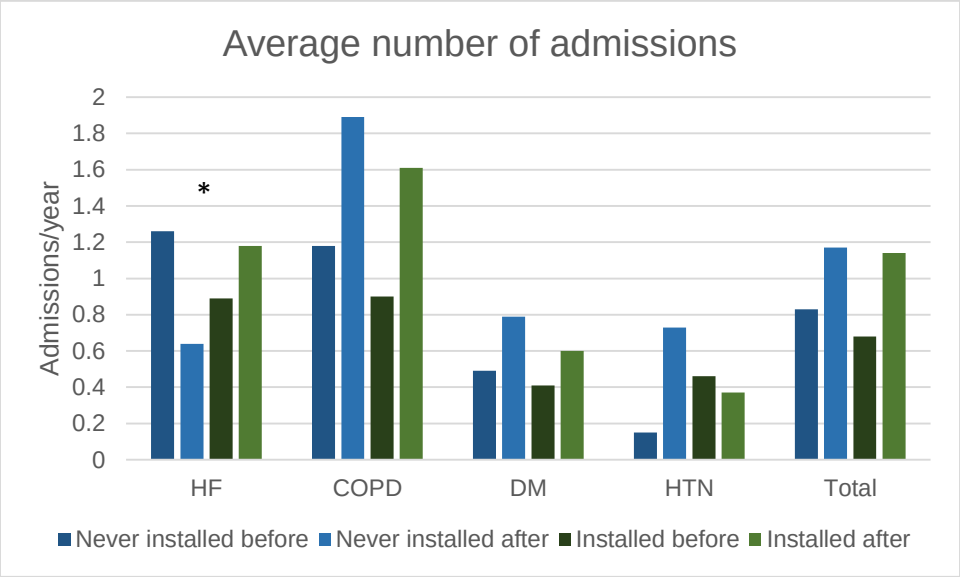
Figure 12 Kaplan-Meier survival plots comparing the never installed versus installed groups in each condition: (a) COPD, (b) Diabetes, (c) Heart Failure and (d) Hypertension

(b) Non-elective hospital admissions

(i) Never installed versus installed

The data for non-elective hospital admissions, pre and post the implementation of telehealth services, for the 'Never installed' versus the 'Installed' grouping are presented in Figure 13 for the four target conditions. The mean number (SD) of non-elective admissions to hospital for the total patient cohort increased slightly in overall terms from 0.8 (1.0) and 0.7 (1.0) admissions/year to 1.2 (2.2) and 1.1 (2.2) admissions/year after the index dates in the 'Never installed' and 'Installed' groups respectively. There was no statistical significant difference between the two groups ($p>0.05$). Please note that all p-values referred to in this and

the following sections relate to the change ((before minus after) in the never installed group versus the change (before minus after) in the installed group. Patients with HF showed an anomalous decrease in the mean number of admissions from 1.3 (1.5) to 0.6 (0.9) admissions/year in the 'Never installed' group and an increase in the average number of admissions from 0.9 (1.0) to 1.2 (1.6) admissions/year in the 'Installed' group ($p<0.05$). Data for patients with COPD and DM show no statistically significant difference between the never installed and installed groups, albeit with an increased hospitalisation rate over time in both the installed and never installed groups. The hypertension group showed the opposite trend, indicative of a positive impact of telehealth provision on reducing hospital admissions, but as noted above, the number of patients in this group is low and the results were not statistically significant.



* indicates significant difference ($p<0.05$) between groups.

Figure 13 Comparison of mean number of non-elective admissions between 'Never installed' and 'Installed' groups pre and post enrolment for telehealth services.

(ii) Never installed versus successful and ongoing

The data for non-elective hospital admissions, pre and post the implementation of telehealth services, for the 'Never installed' versus the 'Successful and ongoing' grouping are presented in Figure 14 for the four target conditions. The mean number (SD) of non-elective admissions to hospital increased from 0.8 (1.0) and 0.7 (1.0) admissions/year to 1.2 (2.2) and 1.1 (2.2) admissions/year for the patients in the 'Never installed' and 'Successful and ongoing' groups, respectively. There was no statistical significance difference between these two groups or for the individual target groupings (p>0.05).

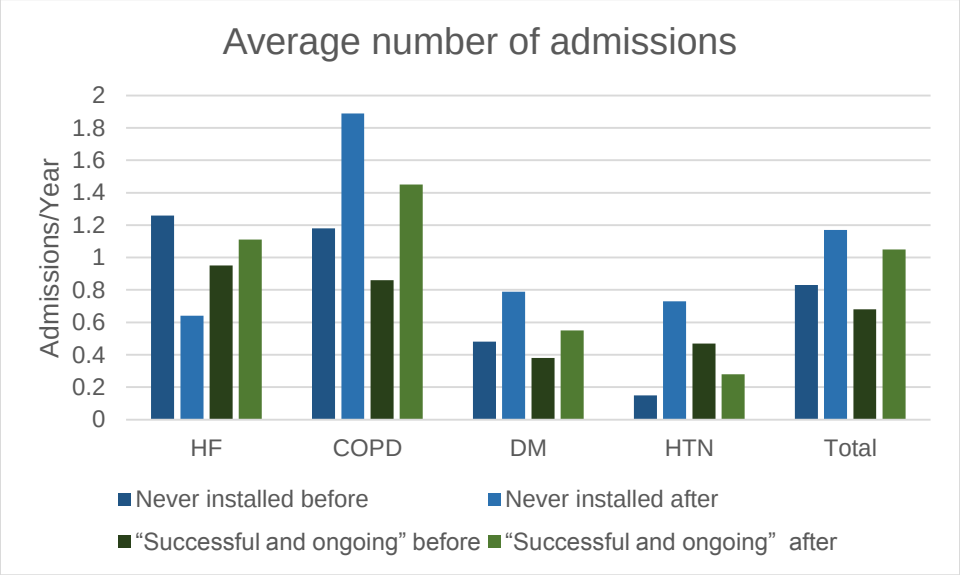
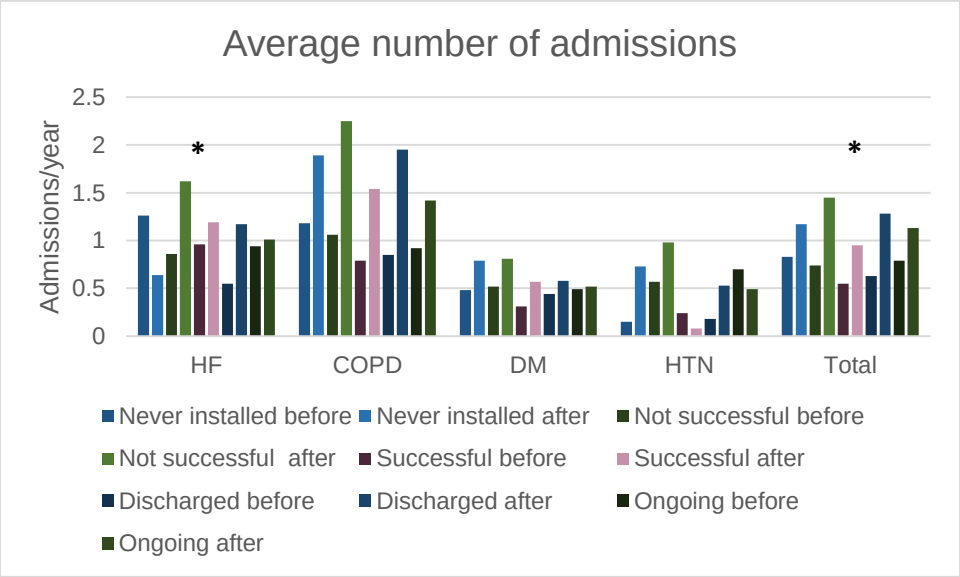


Figure 14 Comparison of mean number of non-elective admissions between 'Never installed' and 'Successful and ongoing' groups pre and post enrolment for telehealth services.

(iii) Never installed versus not successful, successful, discharged and ongoing

The data for non-elective hospital admissions, pre and post the implementation of telehealth services, for the 'Never installed' versus the 'Successful', 'Not successful', 'Discharged' and 'Ongoing' groupings are presented in Figure 15 for the four target conditions. The mean number (SD) of non-elective admissions to hospital followed the same pattern as previously (Figures 13 and 14). In patients with HF the "Never installed" group differed statistically from the 'Not successful' group and 'Discharged' groups ($p<0.05$). This was driven by the large fall in admissions for the post implementation period for the 'Never installed' group. Patients with COPD, DM and HTN had no significant differences in the average number of admissions between the comparison groups ($p>0.05$).



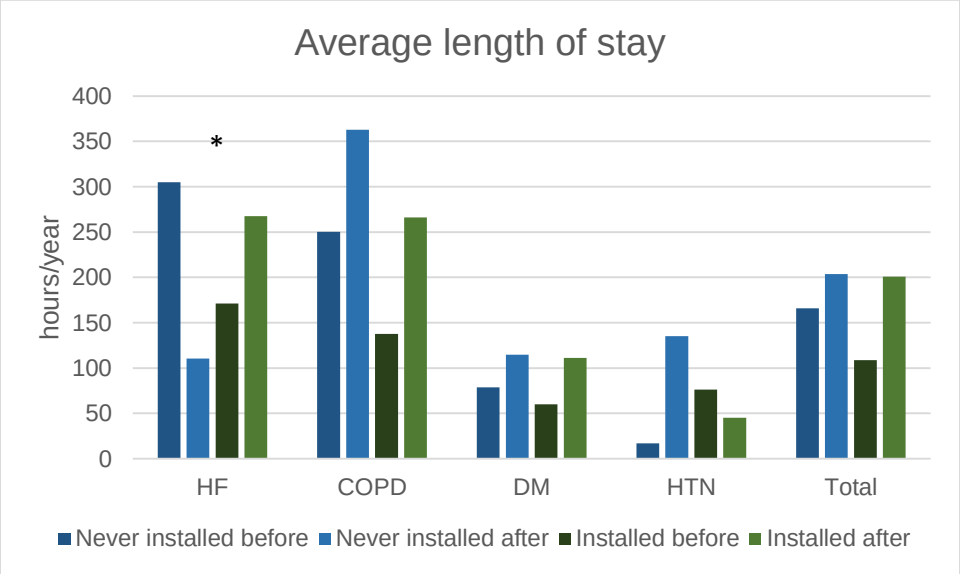
* indicates significant difference ($p<0.05$) between groups.

Figure 15 Comparison of mean number of non-elective admissions between 'Never installed', 'Not successful', 'Successful', 'Discharged' and 'Ongoing' groups pre and post enrolment for telehealth services.

(c) Length of hospital stay

(i) Never installed versus installed

The data for length of hospital stay, presented in mean number of hours per year, pre and post the implementation of telehealth services, for the 'Never installed' versus the 'Installed' groups of patients, are presented in Figure 16 for the four target conditions. The mean length of stay (SD) in hospital for the total patient group increased from 165.6 (260.9) and 108.6 (231.5) hours /year to 203.8 (433.1) and 200.8 (503.6) hours/year after the index dates in the 'Never installed' and 'Installed' groups, respectively. There was no statistically significant difference between the two groups ($p>0.05$). Again, linked to the anomalous decline in hospitalisations for the 'Never installed' patients with HF, there was a decrease in average length of stay from 304.8 (418.8) to 110.6 (195.1) hours/year in the 'Never installed' group, compared to an increase in average length of stay from 171.2 (263.4) to 267.5 (559.7) hours/year in the 'Installed' group. This difference is statistically significant ($P<0.05$). Patients with COPD, DM and HTN had no significant difference in average length of stay between the 'Never installed' and the 'Installed' groups.

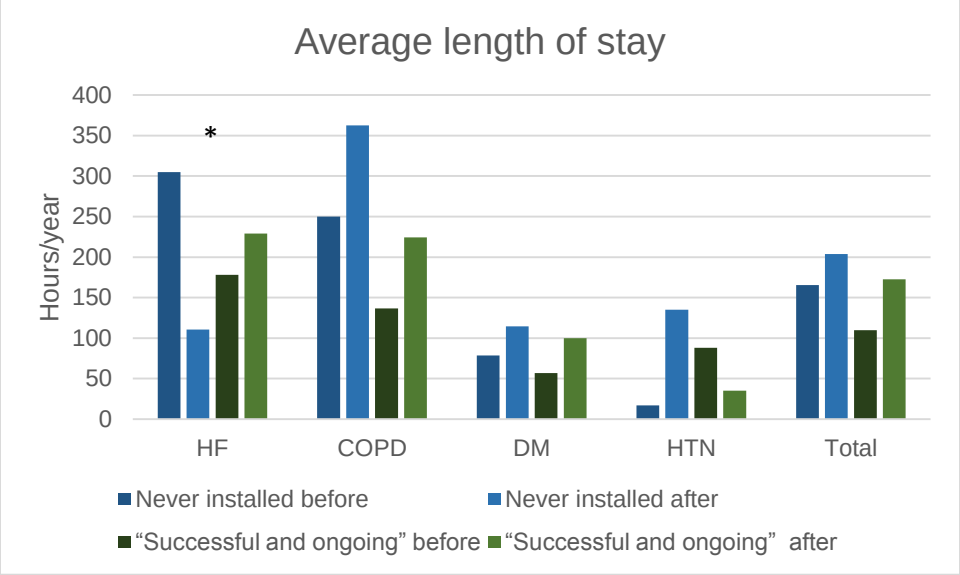


* indicates significant difference ($p<0.05$) between groups.

Figure 16 Comparison of mean length of hospital stay (hours per year) in the 'Never installed', versus the 'Installed' groups pre and post enrolment for telehealth services.

(ii) Never installed versus successful and ongoing

The data for length of hospital stay, presented in mean number of hours per year, pre and post the implementation of telehealth services, for the 'Never installed' versus the 'Successful and ongoing' groups of patients, are presented in Figure 17 for the four target conditions. The average length of stay (SD) in hospital for the group as a whole increased from 165.6 (260.9) and 109.9 (243.5) hours/year to 203.8 (433.1) and 172.4 (463.8) hours/year after the index dates for the 'Never installed' versus the 'Successful and ongoing' groups, respectively. There was no statistically significant difference between the two groups ($p>0.05$). As before, the decrease in the average length of stay in the HF "Never installed" group led to a significant difference between that group and the 'Successful and ongoing' HF group ($p<0.05$). Patients with COPD, DM and HTN had no significance difference in their average length of stay between pre and post telehealth service implementation.

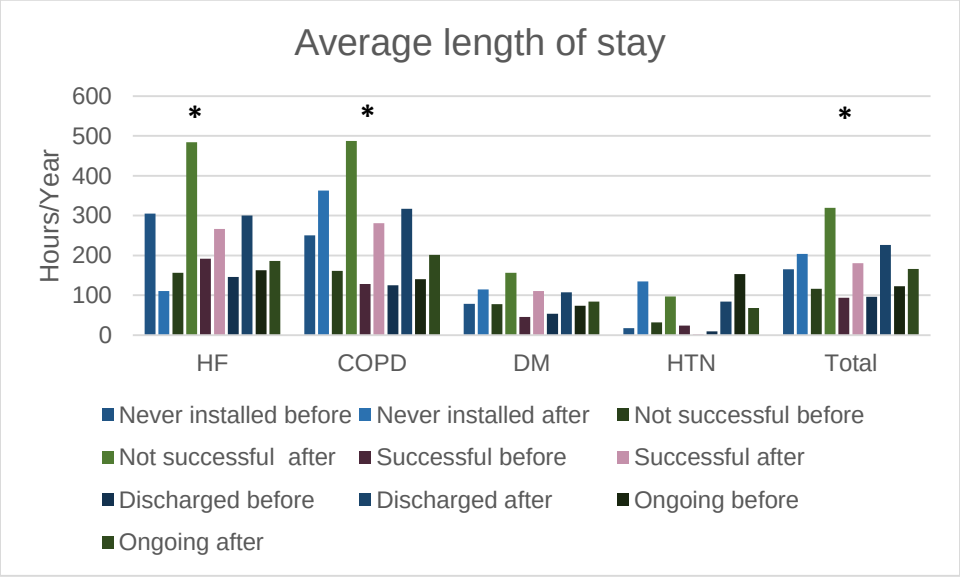


* indicates significant difference ($p<0.05$) between groups.

Figure 17 Comparison of mean length of hospital stay (hours per year) in the 'Never installed', versus the 'Successful and ongoing' groups pre and post enrolment for telehealth services.

(iii) Never installed versus not successful, successful, discharged and ongoing

The data for length of stay, presented in mean number of hours per year, pre and post the implementation of telehealth services, for the 'Never installed' versus the 'Successful', 'Not successful', 'Discharged' and 'Ongoing' groupings are presented in Figure 18 for the four target conditions. The length of stay in hospital was higher after telehealth introduction ($p<0.05$) in the 'Not successful' versus the 'Never installed' and "Ongoing" groups for the total population. In patients with HF, as before, the 'Never installed' group reached statistical significance ($p<0.05$) compared to the 'Not successful' group. In patients with COPD, the 'Ongoing' group differed statistically from the 'Not successful' group. For patients with DM and HTN there were no significant differences in the length of stay between the comparison groups ($p>0.05$).



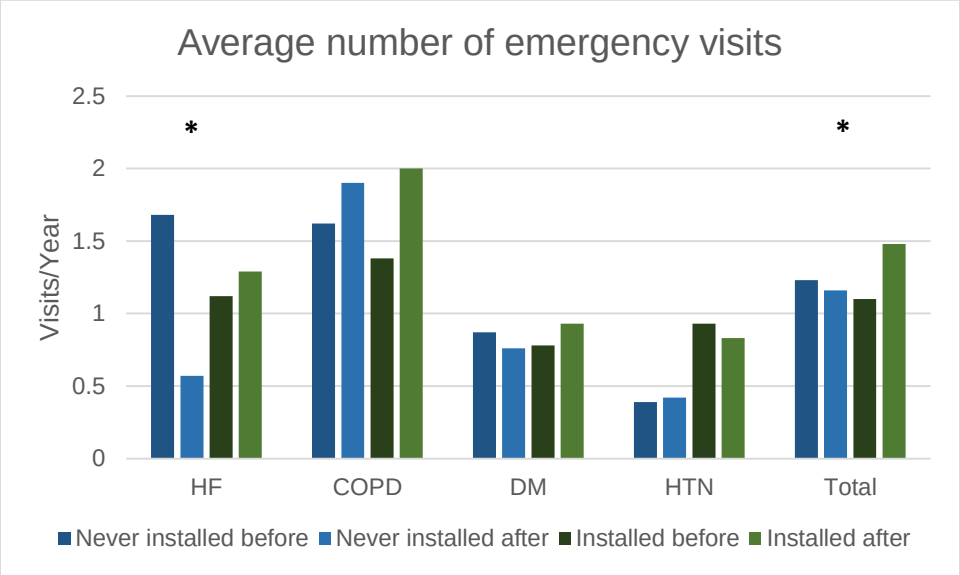
* indicates significant difference ($p<0.05$) between groups.

Figure 18 Comparison of mean length of hospital stay (hours per year) in the 'Never installed', versus 'Not successful', 'Successful', 'Discharged' and 'Ongoing' groups pre and post enrolment for telehealth services.

(d) Emergency room visits

(i) Never installed versus installed

The data for emergency room visits per year, pre and post the implementation of telehealth services, for the 'Never installed' versus the 'Installed' groupings are presented in Figure 19 for the four target conditions. The mean number (SD) of emergency visits for the total patient cohort changed from 1.2 (1.3) and 1.1 (1.5) visits/year to 1.2 (2.3) and 1.5 (2.5) visits/year after telehealth introduction in the "Never installed" and "Installed" groups respectively. There was a statistical significant difference between the two groups, i.e. a greater number of emergency room visits post telehealth implementation in the installed group. As was the case with hospitalisations, patients with HF exhibited a decrease in the average number of emergency visits from 1.7 (2.0) to 0.6 (0.8) visits/year in the 'Never installed' group and an increase in the average number of emergency visits from 1.1 (1.2) to 1.3 (1.6) visits/year in the 'Installed' group ($p<0.05$). There were no statistically significant differences pre- and post- telehealth enrolment for patients with COPD, DM and HTN ($p>0.05$).

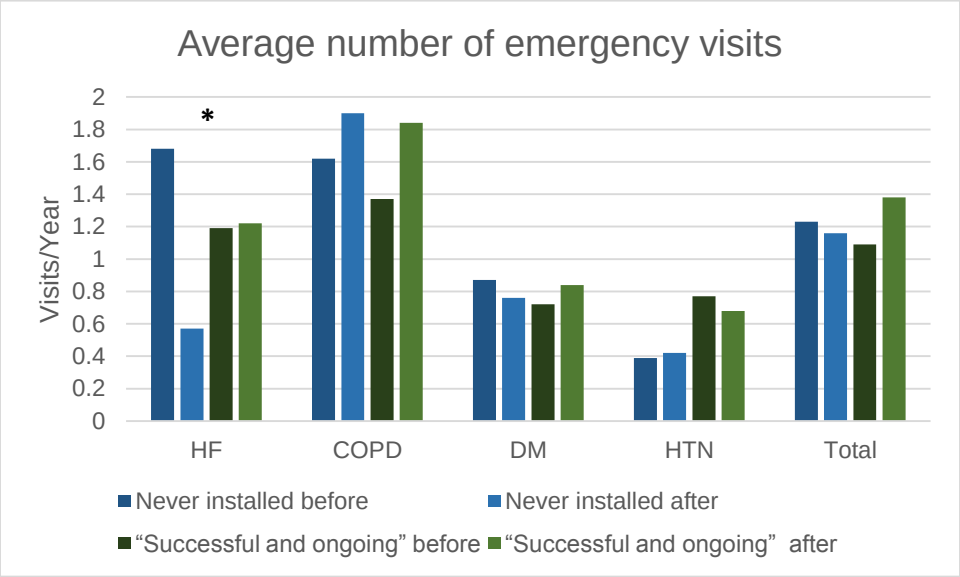


* indicates significant difference ($p< 0.05$) between groups.

Figure 19 Comparison of mean number of emergency visits per year in the 'Never installed', versus 'Installed' groups pre and post enrolment for telehealth services.

(ii) Never installed versus successful and ongoing

The data for emergency room visits per year, pre and post the implementation of telehealth services, for the "Never installed" versus the 'Successful and ongoing' groups are presented in Figure 20 for the four target conditions. Telehealth was not associated with a statistically significant change in the average number of emergency visits when all (total) patients were considered. Patients with HF showed a decrease in the average number of emergency visits from 1.7 (2.0) to 0.6 (0.8) visits/year in the 'Never installed' group with no change observed in the 'Successful and ongoing' group, leading to a statistically significant difference ($p<0.05$). For patients with COPD, DM and HTN there were no statistically significant differences between the pre and post telehealth groups ($p>0.05$).

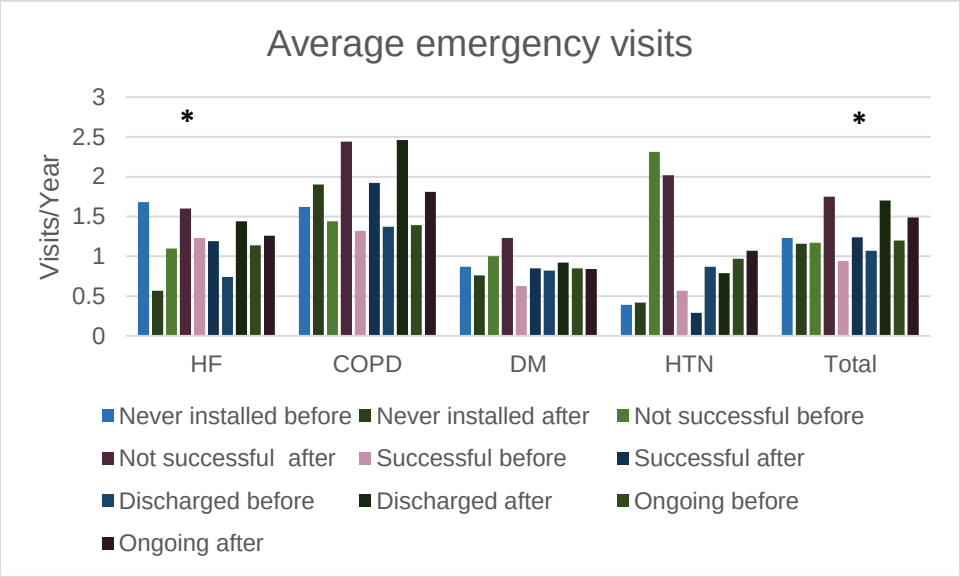


* indicates significant difference ($p<0.05$) between groups.

Figure 20 Comparison of mean number of emergency visits per year in the 'Never installed', versus 'Successful and ongoing' groups pre and post enrolment for telehealth services.

(iii) Never installed versus not successful, successful, discharged and ongoing

The data for emergency room visits per year, pre and post the implementation of telehealth services, for the 'Never installed' versus the 'Not successful', 'Successful', 'Discharged' and 'Ongoing' groups are presented in Figure 21 for the four target conditions. The difference in the mean number of emergency room visits for the total patient cohort reached statistical significance ($p<0.05$) between the 'Never installed' group and the 'Not successful' and 'Discharged' groups. In patients with HF, 'Never installed' statistically differed from the other groups ($p<0.05$). For patients with COPD, DM and HTN there were no statistically significant differences between the pre and post telehealth groups ($p>0.05$).



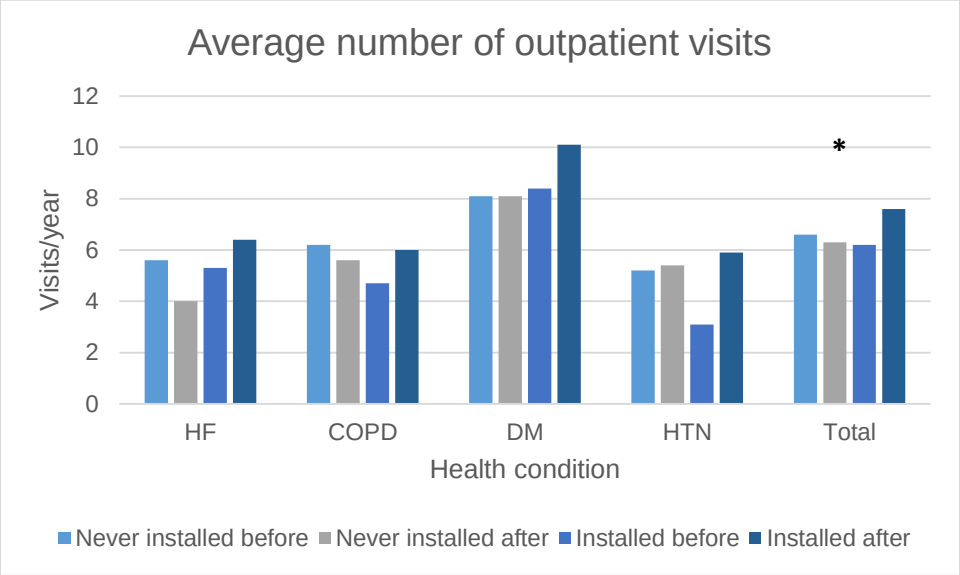
* indicates significant difference ($p<0.05$) between groups.

Figure 21 Comparison of mean number of emergency visits per year in the 'Never installed' versus 'Not successful', 'Successful', 'Discharged' and 'Ongoing' groups pre and post enrolment for telehealth services.

(e) Number of outpatient visits

(i) Never installed versus installed

The data for outpatient visits per year, pre and post the implementation of telehealth services, for the 'Never installed' versus the 'Installed' groupings are presented in Figure 22 for the four target conditions. The difference in the average number of outpatient visits for the total patient cohort reached statistical significance ($p<0.05$) between the 'Never installed' group and the 'Installed' group, with visits becoming more likely after implementation in the installed group: but no statistically significant differences were noted within the individual condition categories (HF, COPD, DM and HTN: $p>0.05$ in all cases).

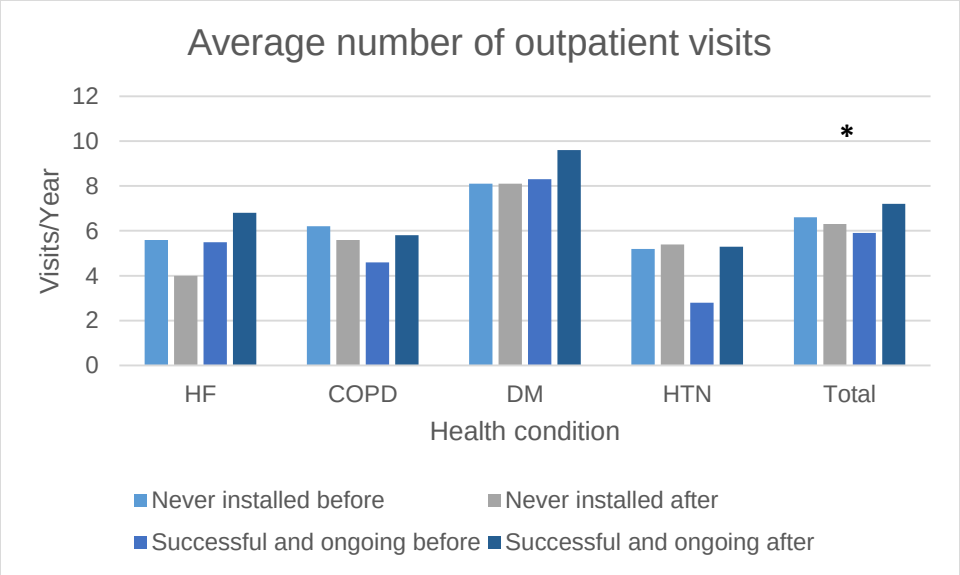


* indicates significant difference ($p<0.05$) between groups.

Figure 22 Comparison of mean number of outpatient visits per year in the 'Never installed', versus 'Installed' groups pre and post enrolment for telehealth services.

(ii) Never installed versus successful and ongoing

The data for outpatient visits per year, pre and post the implementation of telehealth services, for the 'Never installed' versus the 'Successful and ongoing' groups are presented in Figure 23 for the four target conditions. The difference in the average number of outpatient visits for the total patient cohort reached statistical significance ($p<0.05$) between the 'Never installed' group and the 'Successful and ongoing' group, with visits becoming more likely after implementation in the 'Successful and ongoing' group. When the individual condition categories (HF, COPD, DM and HTN) are considered separately, no statistically significant differences were noted ($p>0.05$ in all cases).

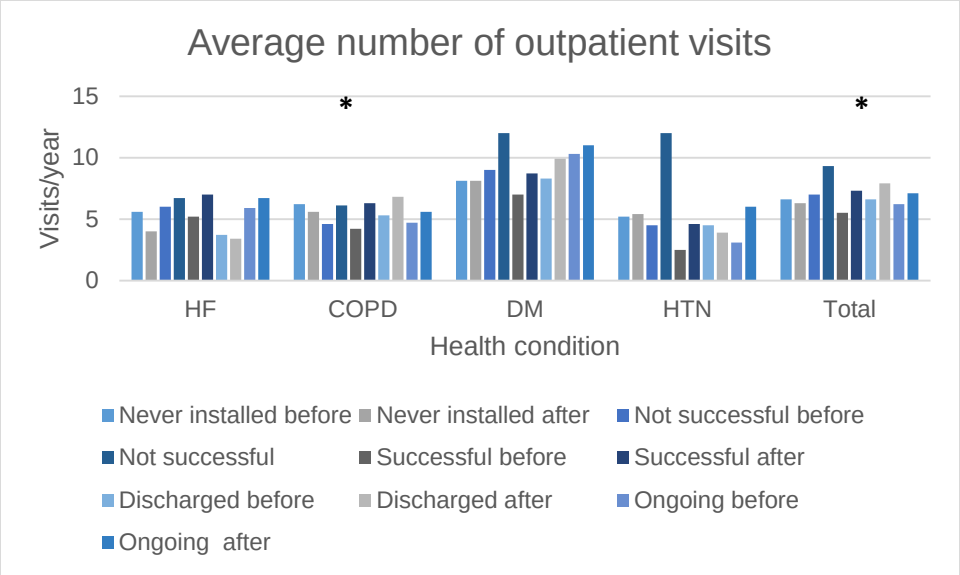


* indicates significant difference ($p<0.05$) between groups.

Figure 23 Comparison of mean number of emergency visits per year in the 'Never installed' versus 'Successful and ongoing' groups pre and post enrolment for telehealth services.

(iii) Never installed versus not successful, successful, discharged and ongoing

The data for outpatient visits per year, pre and post the implementation of telehealth services, for the 'Never installed' versus the 'Not successful', 'Successful', 'Discharged' and 'Ongoing' groups are presented in Figure 24 for the four target conditions. The difference in the average number of outpatient visits for the total patient cohort reached statistical significance ($p<0.05$) between the 'Never installed' group and the 'Not successful' and 'Successful' groups. In patients with COPD, there was also a statistically significance difference between the latter comparison groups: but no statistically significant difference were noted for the other individual condition categories (HF, DM and HTN: $p>0.05$ in all cases).



* indicates significant difference ($p<0.05$) between groups.

Figure 24 Comparison of mean number of emergency visits per year in the 'Never installed' versus 'Not successful', 'Successful', 'Discharged' and 'Ongoing' groups pre and post enrolment for telehealth services.

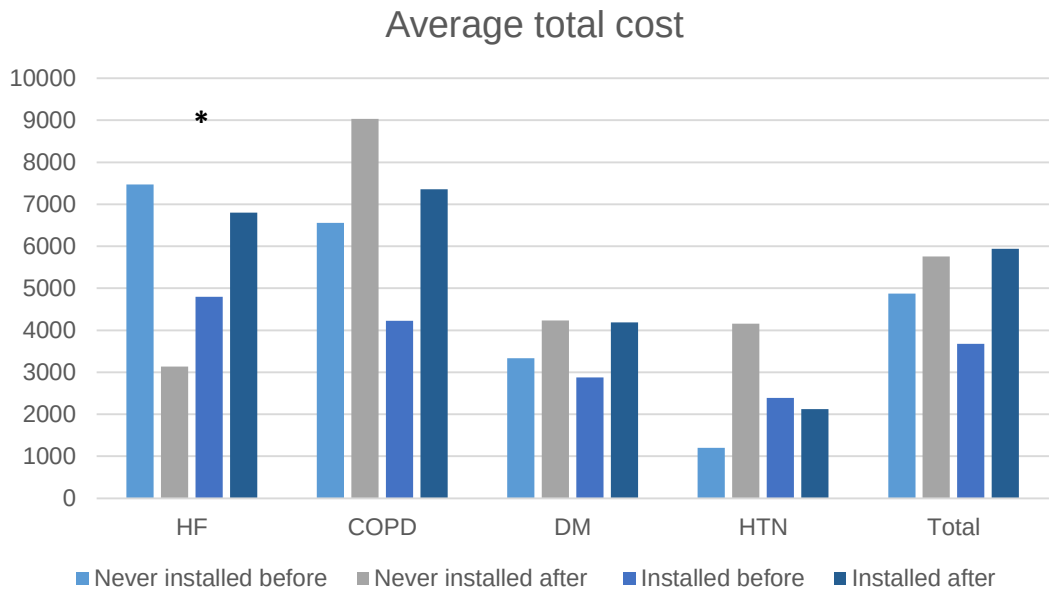
5.3 Health economic analysis of the telehealth programme

5.3.1 Cost of healthcare service use and interaction by patient type

Since reliable data on GP visits / call-outs were not available to the research team, the economic analysis focused on the utilisation of hospital based services. Results for the same group comparisons as were carried out for hospital utilisation are presented in Figures 25, 26 and 27. Not surprisingly the results mirror the findings for average length of stay (Figures 16, 17 and 18) because hospital 'hotel' charges dominate overall costs of healthcare delivery.

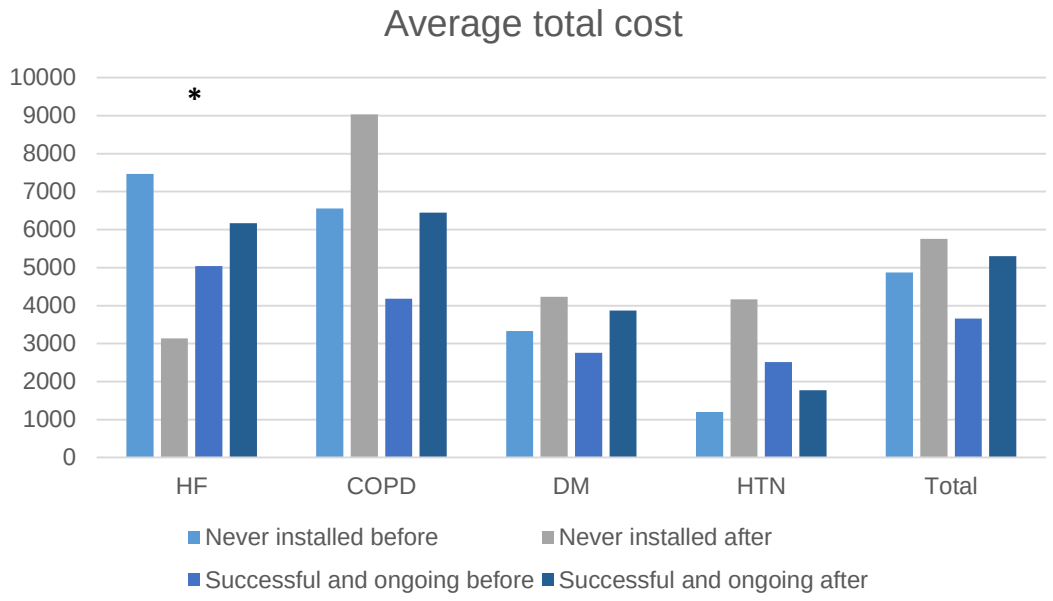
The mean cost per year for the patient groupings was highest for patients with COPD and heart failure and lower for patients with diabetes and hypertension. In general the results were not statistically significant ($p>0.05$) although the anomalous heart failure results (decreased hospital utilisation after introduction of telehealth in the 'Never installed' group) led to a small number of statistically significant findings (Figures

22 and 23). Within this economic section the 'Not successful' group stands out as having the largest differential between pre and post introduction of telehealth services, with markedly higher post intervention costs. Data used to construct the figures are included in Appendix 7.



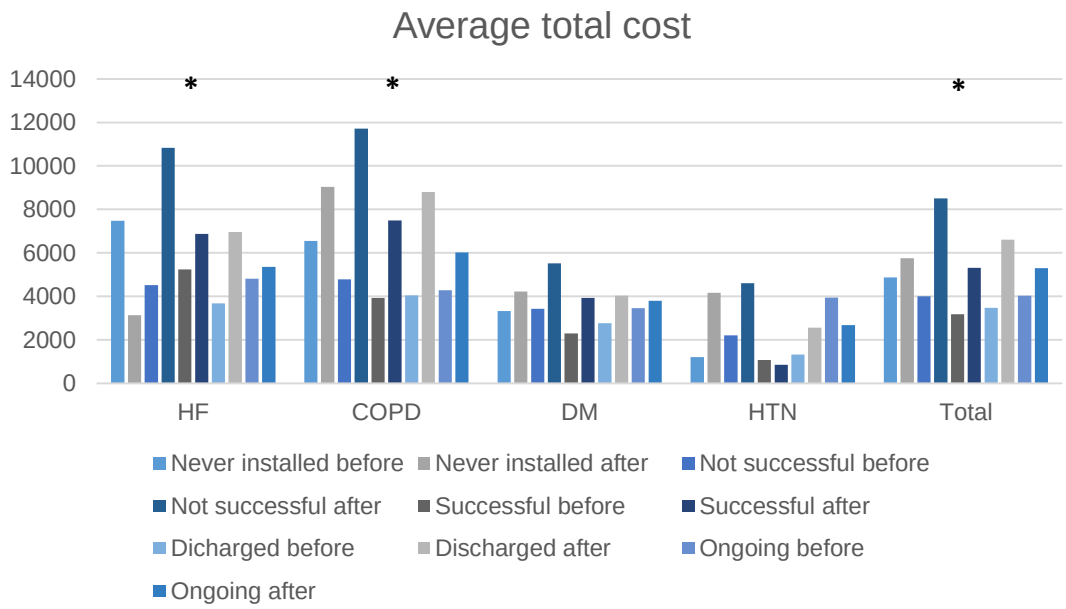
* indicates significant difference (p< 0.05) between groups.

Figure 25 Comparison of mean hospital based costs between 'Never installed' and 'Installed' groups pre and post enrolment for telehealth services.



* indicates significant difference (p<0.05) between groups.

Figure 26 Comparison of mean hospital based costs between 'Never installed' and 'Successful and ongoing' groups pre and post enrolment for telehealth services.



* indicates significant difference (P < 0.05) between groups.

Figure 27 Comparison of mean hospital based costs between 'Never installed' and 'Not successful', 'Successful', 'Discharged' and 'Ongoing' groups pre and post enrolment for telehealth services

5.3.2 Cost of telehealth service

The total number of patients referred to the service was between December 2011 and end of May 2015 was 4216. At the end of July 2015, 1030 patients were still on the service. The total cost for this period has been estimated as £6,744,987.81 (mean: £1599.8548, £959.6800 and standard deviation: 1690.98847). For further details on telehealth service costs, please see Appendix 7, Tables 7.16-7.24.

5.4 Qualitative study

All interviews / discussions were recorded, fully transcribed verbatim by an independent transcriber and the transcript checked against the recording. Each group of participants (focus groups, and interviews with carers, health professionals, stroke patients and patients discharged/declined) was analysed separately. To ensure minimisation of researcher bias during theme development, two researchers independently coded the transcripts and developed themes using the constant comparative method. Codes were recorded using NVivo. Themes were discussed with the wider research team to help further refine the analyses and a thematic framework was developed in line with the approach and aims of this study.

5.4.1 Patient views of telehealth programme: focus groups

One focus group was held in each of the five Trusts in Northern Ireland. Focus groups, incorporating patients and their carers, ranged in size from three participants to seven. A total of 24 patients agreed to take part and 15 attended. Reasons for non-attendance were illness, other appointments and one person had died. Participants had a range of conditions, namely COPD (n=8), diabetes (n=6) and heart disease (n=1). The focus groups in each Trust had the following numbers of participants: Belfast – 3 patients and 1 carer, average patient age 72.3 years; Northern – 3 patients and 2 carers, average patient age 67.6 years; South Eastern – two patients and 1 carer, average patient age 51.0 years; Southern – 3 patients and 1 carer, average age 66.0 years; Western 4 patients and three carers, average patient age 73.3 years.

Analysis of views

Patients were unanimously positive about telemonitoring, with the main benefit being the reassurance it gave them that a health professional was monitoring them constantly. Some patients, particularly those with COPD, reported real clinical benefits because telemonitoring acted as an early warning system – early indications of infection were picked up by triage nurses because readings were observed daily, allowing treatment to be started quickly. Patients said that there was no doubt that this had saved them hospital stays – and staying out of hospital was a major benefit.

Analysis of the data led to the themes outlined below. Participants are coded with the annotation FG# (focus group number 1 to 5 according to Trust – we do not identify Trust here for confidentiality reasons), M/F (gender), participant number in group, condition (C=COPD, D=diabetes, H=heart disease). A number of spouses, other family members and carers of participants were present; they are coded accordingly.

Impact on health and healthcare utilisation

Many patients said that telemonitoring had made a significant impact on their health and hospital stays. This COPD patient attributed telemonitoring to keeping him out of hospital ‘on several occasions’ during the previous two years:

"Over the last two years it has worked very well for me and I've only been in hospital once over that period of time, so I would be a big fan of it (telemonitoring). At least I can lead somewhat of a normal life. Before, I could guarantee that by the eighth week I was back in hospital again, and I was usually in for a six to eight week stay." (FG3, M1, C)

These sentiments were echoed by another COPD patient's carer:

"That (readings going through to triage nurses) will tell you if you're high, low or in between and that will save you running into a crisis." (FG2, F1 husband, C)

Overall, patients said that their contact with health professionals had been less often since having telemonitoring, and that they welcomed that.

"I would say so (had fewer visits to GP). I would have probably gone in a bit more often (before telemonitoring) as I was concerned about the pains I was having. I would say like I was being watched and it was all right then or they would come back to me." (FG5, M3, H)

Contact with professionals connected with telemonitoring, including specialist nurses and triage nurses, was unanimously praised.

"They are always good … they are good at looking after you." (FG5, M1, C)

Encouragement from health professionals helped develop confidence for patients:

"I said to my chemist 'you know, my oxygen levels are always good' and she said 'it's because you take your medication properly' so that was a benefit to me, that I'm doing something right, you know, it really does make me feel safe, it really does." (FG1, F2, C)

Patients also derived satisfaction from their belief that they were visiting their healthcare professional less often:

"I'm sure it's also a comfort to the doctors because at least that's less visits." (FG3, F1 relative, C)

Incentive for use

For diabetes patients using the track and trend service, it was reported that telemonitoring acted as an incentive to maintain a healthy diet because of the knowledge that someone else – not just themselves – was monitoring blood sugar levels.

"I think you're supposed to use it for six months but because my blood sugars were coming down so well and it encouraged me to make sure I ate properly, I asked if I could stay on it longer and they said yes, and I was on it for about a year." (FG4, F1, D)

The same patient said that after coming off telemonitoring, she no longer adhered to her healthy diet:

"It was easier when I was on it because I wasn't tempted to eat biscuits or sweets or crisps … and you know my blood sugars did come down … but I've gone sideways again and they're talking about actually putting me on to it again."

The biggest incentive, she said, was that if professionals were making time and effort to help her, she needed to do the same:

"It was very valuable for me because definitely it made me think 'you don't need that piece of chocolate, you don't need it', so it definitely made me think twice before I would put anything that I shouldn't have into my mouth. Because I knew I was being monitored … they were trying to help me so I had to try and help myself."

Another diabetes patient said that although he was strict with his diet anyway, he found satisfaction in aiming for good readings:

"I found just to see the results coming up it annoyed me if they were high and it made you feel good if they weren't high." (FG4, M1, D)

"It's like a policeman in the house keeping an eye on you … there's nowhere to hide from it if you don't put your readings in." (FG2, M1, D)

For a COPD patient, the incentive from telemonitoring was to address issues early rather than precipitating a serious exacerbation:

"This (telemonitoring) is ideal for me because it means somebody's there to say 'no, stop, address this now' rather than what I would have been doing which was ploughing on and keeping on the go." (FG1, F1, C)

She was adamant that this had resulted in fewer hospital admissions.

Reassurance and support

Peace of mind was a major theme with participants stating that this was perhaps the biggest advantage of telemonitoring. The words 'reassurance', 'safety net' and comfort zone' were expressed repeatedly.

"It's peace of mind. After my (heart) surgery I had pains and aches and I often wondered am I having another heart attack? If you are on the monitoring you knew it was being watched, your heart rate and all was being watched and you had peace of mind." (FG5, M3, H)

"It's like a security blanket." (FG2, F1, C)

One patient acknowledged that while telemonitoring had not helped to improve his actual condition, COPD, which he understands is terminal, but it has given peace of mind:

"It gave me contentment … if I went to bed with a bit of wheezes … the next day I would go on the telemonitoring and if the reading was 95 well I'm ok." (FG5, M1, C)

Further, his wife also found reassurance:

"It gave me peace of mind to have it in the house." (FG5, M1 wife, C)

Patients derived reassurance not only from knowing that their symptoms were stable and that a professional was keeping a constant eye on them, but also through believing that they were less of a burden on the health service. Having the tools to hand in their own home meant they could easily take readings at any time:

"My heart … was speeding this morning. But when I did it (measured heart rate) an hour later it had settled down … I would have been the first to be down in the doctors' and see what is going on, but it could settle down and it's a total embarrassment." (FG3, M1, C)

Family members also experienced great reassurance from knowing that their loved one was being monitored regularly:

"It takes the pressure off, you know, knowing that if he needed someone they are on the phone, because I can't get up now (to his house) as often as I did." (FG3, M2 relative, D)

"My wife … it gives her reassurance; even the kids, it gives them reassurance. To me it's a great safety net." (FG3, M1, C)

"They (family) were all glad that I was doing it and they were glad that I was being more careful with myself for my own sake." (FG4, F1, D)

This patient's husband agreed, saying that the constant monitoring was key:

"With your six-monthly check-ups when you go to see the consultant, if you do misbehave and eat the sweet stuff, you know you've got maybe four or five months to catch up and be good. Whereas with the machine, you know, it's instant, and it's the big brother aspect and it's very, very beneficial." (FG4, F1 husband, D)

This reassurance was reinforced through the support received from triage nurses. Patients were impressed at how quickly they were contacted if there was a query, and about the genuine care which was shown towards them. This added to the feeling of reassurance and security for patients.

"The nurses will ring back and say 'You're not too good today. Do you want me to ring your doctor or do you want to go to out of hours? Have you got the number?' You know, they are always very friendly and very supportive. And they ring you back, you know, within about half an hour of the readings." (FG3, F1 relative, C)

"It (telemonitoring service) was perfect in every way and they were very courteous." (FG4, F1, D)

"They have told me that if I need them (nurses) they will come out, I mean, how secure can you feel after that?" (FG1, F2, C)

"What I love about it is I mean when I do all my checks every morning … if my blood pressure was down, they were on the ball and they always ring me is something is not right. I wouldn't be without it, they're all lovely (triage nurses), I've never met them but I recognise their voices, lovely team you know." (FG2, F2, C)

Empowerment and education

Patients spoke of learning more about their own condition and becoming confident in this increasing knowledge of what their normal readings should be.

"I knew what my blood pressure should be." (FG5, M3, H)

"You feel in control, not somebody else. You feel in control of your own health and what's going on. It gives you a certain amount of independence, and responsibility that you're not relying on somebody else all the time." (FG3, M1, C)

A COPD patient argued that he had become proficient at taking his measurements but he still relied on the professional to make judgements about his condition:

"I can read my SPO2 from my finger and I can take my blood pressure, I can weigh myself and take my temperature, but that's the mechanical part of it, that's using the machinery if you like, but it doesn't tell me a lot personally, maybe it tells whoever's monitoring it at the other end." (FG1, M1, C)

The carer of a COPD patient said it was enough to be aware that action needed to be taken when readings were at a certain level:

"In our particular case, we're not experts in what's wrong with us but it's an understanding of what happens if and what happens if not, and you can take appropriate action." (FG2, F1 husband, C)

Routine and convenience

Routine and convenience were cited as benefits of telemonitoring. Participants reported that taking their readings at set times during the week became part of their routine and was not disruptive.

"It had minimal effect on me. It was just a wee routine you go through, like having your breakfast every morning or brushing your teeth. It takes literally two minutes." (FG5, M2, D).

"It only takes a few minutes, it doesn't inconvenience me in any way and I couldn't say it has made any difference to my way of life." (FG1, M1, C)

However an alteration to that routine meant that some forward planning is required:

"I've got into a routine now so I'm happy to stick with the same time every day. I get up at seven o'clock on a routine day but it's awkward when you're on business trips and you're away. It knocks the whole thing off. I just simply phone and say 'I won't be monitoring for the next couple of days'. It just takes the whole strain and stress off that." (FG5, M2, D)

Patients said that they had found telemonitoring to be extremely convenient because of how simple it was to use:

"I put it (readings) into the wee machine and it goes off (to the triage nurses). I don't used to have to write it all down in books. So it saves a lot of work, for me and the nurse." (FG3, M2, D)

"I just thought it was great. It saves you any bother having to run in (to the clinic) to see her (the specialist nurse), she could check (readings via telemonitoring)." (FG2, M1, D)

"It saves you going down to (hospital) … that saves you a lot of time, it saves her (wife) a lot of time and it saves the health service a lot of time." (FG2, F1 husband, C)

Resources

Patients were unanimously positive about the equipment. Participants stressed that it was a major benefit that the equipment was easy to use because they were dealing with a chronic illness – they did not desire anything more complicated which they believed might have caused stress.

"Sometimes it had the odd wee technical issue but not very often. Generally speaking it's a minor inconvenience." (FG5, M2, D)

"I'm happy enough with the system as it is." (FG3, M1, C)

Some patients with diabetes used the monitor to submit seven days' worth of readings once a week:

"The voice would come on (from the machine) 'please do your update' so you just put your readings into the machine and then it went right through to them." (FG4, F1, D)

"I had no problems with it at all. You came in from work and five minutes later it was done." (FG4, M1, D)

One patient mentioned that if the machine was set to ask for readings to be submitted at a certain time, it could occasionally disturb a peaceful morning:

"Waking me up in the morning when I'm trying to have a good sleep. Sometimes you love a lie in and then when you get the voice booming 'time for your …' I'm saying 'go away'." (FG2, F1, C)

Dependence and continuation

Many patients using telemonitoring expressed strong support for the continuation of the service:

"That's my bone of contention. I'm losing it in March. I really don't understand the health board's idea of financial management. Surely it's cheaper to keep that in your home than to keep you in hospital." (FG3, M1, C)

This patient said he would go as far as buying his own monitor if it was taken away:

"The hospital is the last resort, it really is. In my case I would have to think about going down the line of buying one. It has to be cheaper to keep that in my home than to keep me in hospital."

Others also dreaded the thought of losing telemonitoring:

"As long as I don't lose it, it doesn't bother me. I don't want to lose the monitor." (FG3, F2, D)

"I really, really would find it very difficult to cope without it." (FG2, F1 husband, C)

Many patients were in favour of continuing the service.

"I think the final analysis is just keep it." (FG3, M2 relative, D)

"Just don't take it off us." (FG3, F2, D)

"I think it's going well and it it's not broke don't fix it." (FG3, M1, C)

"I think if you find anybody that's against it there's something wrong with them." (FG2, M1, D)

5.4.2 Patient views of telehealth programme: carers

Six carers of patients who used telemonitoring were interviewed. They were spouses, children or friends of the patients. Five patients were being monitored for COPD and one for diabetes; five of the six patients had multi-morbidities.

Analyses revealed the similar themes emerging from the data as those from the patient interviews, ie, impact on health and healthcare utilisation, reassurance and support, convenience, and improved education and self-care. However, some themes emerged which were unique to carers which are highlighted below.

Impact on healthcare and utilisation

Carers recognised that telemonitoring was convenient not only for themselves but also for healthcare professionals:

"As far as the respiratory nurses and that are concerned, it saves them the journey to have to come out and do my dad's stats when they are being done through the monitor." (Carer 2)

This carer added that when the telemonitoring machine showed that her father's oxygen levels had depleted too far, treatment could be started at an earlier stage than if they did not have telemonitoring:

"When it (oxygen level) drops it normally drops under ninety and we would be able to ring the doctor and the doctor would normally come out and give him a quick check and realise that he has some sort of an infection and get steroids on the go and get antibiotics on the go to try and get it cleared up. Where previously it probably would have gone slightly further than that to the point where he would have had to go into hospital." (Carer 2)

Reassurance and support

Reassurance that their patient (who was also a close relative) was being monitored was highlighted as a significant benefit of telemonitoring for five of the six carers interviewed.

"It's like having your own personal nurse, because if something is not right they will come back to you … if they're not happy they will send somebody out to him." (Carer 5)

"You're catching it on much quicker than if he was just sitting there and I would see him having difficulty breathing … it maybe stops him from having to be taken into hospital." (Carer 4)

"They (the nurse and doctor) see (husband) every six months and we have a wee chat and they tell us whether we are doing it right or we are not doing it right, and that I find very comforting, and if I'm worried about anything I can just ring (nurse) and she'll sort me out." (Carer 1)

Peace of mind for a carer was an enormous benefit because they could proceed with daily tasks with less anxiety:

"It gives you that peace of mind, I know when he's going to bed that maybe things are ok, or when he gets up in the morning I could maybe nip out to the shop." (Carer 4)

Carers added that they could take readings at any time of the day or were reassured by regular daily monitoring, all of which added to feelings of reassurance:

"I can do, you can do it at any time if you feel, if I maybe thought as the day went on or something that his breathing was a bit laboured I can put it on and see what the oxygen levels are so it's a good help that way as well, you're not just limited to one occasion in the day." (Carer 4)

"It's just very useful and it puts my mind at ease having it here knowing that if he's being checked out every day and … it puts my mind at ease." (Carer 5)

Only one carer expressed negative views on telemonitoring, which were focused on the system not being tailored specifically enough for the patient. He believed that this caused some time to be wasted answering irrelevant questions.

"To me the questions, some of them are stupid or irrelevant, asking 'have you used your oxygen more than normal?' … she uses it 24 hours a day … we wouldn't increase the amount of oxygen she takes because we're not allowed to." (Carer 6)

This carer also did not understand some of the advice he was given from triage nurses:

"When we take a reading, if it reads 84 then they will ring us and say 'your oxygen levels are low, do you feel ok?', she will say 'yes I'm feeling ok', they'll say 'put the oxygen thing back on and give us another reading, if you take a couple of deep breaths that'll bring the oxygen levels up'. What is the point in that? It defeats the purpose, they shouldn't, in my opinion, be saying that … that one sticking point with me is them telling her how to beat the system instead of playing along with it." (Carer 6)

Empowerment and education

Carers spoke of handling the telemonitoring equipment and learning about their patient's condition, indicating that this resulted in a sense of empowerment.

"I help him out because he would get a wee bit dizzy when he would stand on the scales and things like that and I mean I operate the machine so that he doesn't have much to do." (Carer 5)

"It has certainly helped me to understand what sort of levels of oxygen you would want to be looking out for as danger." (Carer 2)

"I sort of know then, if I take his readings myself obviously, if I would see that maybe he needs a nebuliser he could take it sooner rather than waiting. Just different things you can pick up with the fact that you know that things aren't too good." (Carer 4)

Routine and convenience

Carers appreciated the simplicity of the telemonitoring equipment because it did not add any inconvenience or additional stress to their already busy lives.

"(The equipment is) very simple, amazingly simple. This is the tele-monitoring thing (carer demonstrates how she works her telemonitoring machine) just here beside the telephone in the wall and this is what I sent through this morning … I put the wee strip in there and then I prick his finger and the wee strip here, and then on a Friday I come here and it's all hooked up because some Fridays I might forget and when I get up in the morning the machine is saying "Interview pending". So that's where I… so then I come here and I just have to press those two buttons and put it in there, and then the thing goes through and it sends it through to the centre." (Carer 1)

Another carer found that the equipment was also easy to use and appropriate to her husband's condition:

"It's simple enough, I say it's only a case of once you put it on, obviously the voice starts talking to you and it takes you right through each stage, it's only a case of pressing one button, they ask you 'have you taken all his medication?' and you press 'okay', 'what's his breathing like?', 'okay', it's really only a case of pressing one button. They're simple enough questions and they're all relevant to the COPD." (Carer 4)

Dependence and continuation

Like patients, carers expressed a strong desire to remain on telemonitoring.

"As far as I knew it (telemonitoring equipment) was going in and that was it, and as far as I'm aware it's staying there. So here's hoping! We wouldn't want it to be going away because it has definitely made a difference." (Carer 2)

"We're hoping (to remain on telemonitoring), we don't know …" (Carer 5)

"I would tell you if it wasn't good. It's pointless having it in if it's not, you know what I mean. But I think it's brilliant." (Carer 3)

Patient views of telehealth programme: stroke patients

Four stroke patients were interviewed in their own homes. They were generally using the service for a few months and, like patients and carers previously described, were overwhelming positive about telemonitoring. In a point which may be more relevant to stroke patients than other conditions, patients highlighted the importance of the monitoring equipment being simple:

"I can only think of what happened to me, my mind was in a complete whirl for weeks (after the stroke), it took me weeks to get my thinking straight so if I had anything difficult (equipment) I couldn't have coped. You've got to remember, with respect, that even in a mild situation like mine you're knocked off kilter in a very different way … you have enough in your mind to cope with, I liked that it was clear, it did the job it was meant to and it caused me no more anxiety." (Stroke patient 2)

Patients appreciated the information they received with regular contact from health professionals, in particular their stroke specialist nurse.

"The service, it's not a hundred percent, it's more than that, it's superb." (Stroke patient 2)

"Being kept up to date, (nurse) phoned regularly … it became a source of information between (nurse) phoning and telling you about the different readings that were coming through and it gave you confidence that somebody was there looking after you all the time." (Stroke patient 1)

This, the patient said, was of great benefit to his health:

"It (telemonitoring) was crucial, it really, really was. Without it, (nurse) wouldn't have been able to chop and change (the medication), it was one of the last actions she did, whatever that tablet was she started to get consistent readings and then she said 'look, the telemonitoring, I'm going to take it out because we're quite happy now with the readings coming through."

The patient was happy for the telemonitoring system to be removed after three months of use:

"It was a relief that it wouldn't have gone until it was the right time, so I was quite happy that it was going, that they think I'm reasonably well now."

Another patient agreed that reassurance, for both him and his family, was gained from knowing that readings were being sent directly to specialists:

"I think it is very good because my wife is also consoled … I think the most important thing for us was that it was going to the stroke unit." (Stroke patient 3)

One patient said he had experienced some difficulty with the telemonitoring equipment, but acknowledged that this may have been because he had ignored the written instructions:

"I think it… there's one wee dial that comes up and says 'select'. I think a light comes on. That confused me a couple of times. If you see a light coming on the inclination is to press it, but I pressed it and it is supposed to be only for the technician, and then he had to come out again and show me how to use it … the explanation was probably clear but maybe my receptors weren't keen enough." (Stroke patient 4)

This patient called for more communication in general from healthcare professionals as he was unsure what a variation in his blood pressure meant:

"I would like other people to have more guidelines as to what is abnormal and what's normal. Like you go to your doctor's and every time you go they take your blood pressure, and I don't know what it is. Is two degrees above norm bad or good or whatever? To the non-medical it is not an exact science. Say after this (telemonitoring) was taken off me and somebody sent just a postcard saying 'your readings were such, one of which was rather high' then you would have some feedback. A second class stamp on a postcard, it wouldn't cost that much." (Stroke patient 4).

5.4.3 Patient views of telehealth programme: patients discharged unsuccessfully or who declined the service

Invitations were sent on behalf of QUB by Fold to 100 patients who were discharged unsuccessfully or who declined the service. Two participants agreed to take part and one of these was interviewed. The other did not answer subsequent phone calls after initially agreeing to take part. An additional participant was recruited via the quantitative study.

The two patients were interviewed by telephone. One did not know he had been referred to receive the service and it was never installed, and another found that it was unnecessary. The latter was offered the service after being prescribed insulin for diabetes, however she had never had a problem controlling her condition. "It caused me a lot of stress because when I did my blood sugar in the morning and tried to send it through you couldn't get through, and you were maybe going out and thought 'will I wait or what do I do?', because I wanted to give it a fair go after them coming down and installing it. To me it wasn't a benefit at all. I can see the benefit of it if you need to adjust your medication or need advice."

5.4.4 Health professional views of the telehealth programme

Participant recruitment

The response rate for the 86 health professionals who were invited to take part was 52.3%. Table 13 shows numbers invited and those interviewed. Where reasons for not taking part were given, they included no knowledge/no experience of telemonitoring and therefore believed could offer no opinions, and no mutually suitable time to arrange an interview.

Table 13 Number of health care professionals invited and interviewed

	Invited	Interviewed
Telehealth key worker	28	7
Service development manager	16	8
Pharmacist	12	10
GP	14	8
Triage nurse	10	9
Hospital doctor	16	3
Total	86	45

One interview took place face-to-face while the remaining 44 health professionals were interviewed by telephone. All participants were experienced health professionals, for example, all hospital doctors were

consultants, pharmacists had between 15 to 35 years' experience, general practitioners (GPs) had been qualified as GPs for between 1 and 28 years, service development managers were by definition in senior management roles and telehealth key workers were specialist nurses. Triage nurses were specialists in their roles and all were based at the Fold headquarters, therefore Trust location is not relevant for this group. Interview duration ranged from 9 minutes to 60 minutes with the average length of interview being 22 minutes.

Analysis of views

The six groups of health professional we interviewed could be categorised into those who worked directly with telemonitoring, i.e., telehealth key workers (specialist nurses who work in the community), service development managers and triage nurses; and the remainder, those who did not, the pharmacists, GPs and hospital doctors. Accordingly, we have analysed each of these two groups separately.

5.4.4(a) Health professionals not working directly with telemonitoring (pharmacists/GPs/hospital doctors)

Most views were perceived because this group had no direct experience of telemonitoring. The main themes are detailed as follows.

Awareness of telemonitoring

Pharmacists had little or no knowledge of telemonitoring. Those who had some knowledge had gained this through word of mouth from other professionals or by attending a seminar at which telemonitoring was mentioned.

One pharmacist said during the interview that he was 'talking from a standpoint of ignorance' (pharmacist 5).

Another stated their knowledge of telemonitoring was 'actually nothing, because I've never ever been involved in it' (pharmacist 6).

One had learned of telemonitoring when attending a community pharmacy information event but he was not aware of any of his patients using it.

"I have a brief idea of what it involves, sort of remote access to monitoring of health but I don't know to what capacity." (Pharmacist 7)

Another said she knew of one of her patients who used telemonitoring and that he had found it to be of great advantage:

"He's very restricted with the amount of walking that he can do and his ability to go for hospital visits. It suits him better to be monitored at home and if there's something happening, you know, it can be dealt with without him having to spend a physical effort." (Pharmacist 9)

GPs said that they were officially informed if patients had received telemonitoring. Otherwise, patients may have told them that they were using the service or they might receive telephone calls from community nurses monitoring their telemonitoring results.

"From records, we get correspondence saying they've been on it and then patients as well will mention it." (GP 1)

"I've had the odd phone call from some of the nurses who monitor the telemonitoring." (GP 2)

One of the three hospital doctors interviewed knew about the service because he had been to a training event when telemonitoring was being introduced to the health service.

"I am familiar with it and I've heard colleagues talk about it as well." (Hospital doctor 1).

However, this was not the experience of the other two doctors; they said they would only know which patients were on telemonitoring if the patients themselves told them.

"I might have got a sideways answer from a patient that might have implied that he had been on some form of monitoring but I didn't explore it any more with him." (Hospital doctor 2)
"I'm aware that it's taking place and sometimes a patient who comes to my outpatient chest clinic will tell me that they're on telemonitoring and near enough that would have been the first that I would have been aware that they were." (Hospital doctor 3)

The potential of telemonitoring

Healthcare professionals perceived that telemonitoring had specific potential in terms of what it could do, and the types of patients who should be targeted.

Pharmacists perceived that the aim of telemonitoring to increase more localised healthcare was a worthy one:

"It's an ideal situation obviously. The theme at the moment is to try and prevent people having to stay long term within the secondary care environment and that they can have more primary healthcare and good healthcare within their own environment and at home and that primary healthcare can monitor their condition to prevent these readmissions into secondary care." (Pharmacist 10)

Hospital doctor 1, who was familiar with the service, said that nursing staff would seek his approval to put a patient on telemonitoring, in this case blood pressure monitoring, for 24 hours.

"Reducing the need to come back to an outpatient clinic and get your car parked, sit in a waiting room and then see the doctor and make your way home again when you were actually doing ok anyway is, maybe that could be quite a big role for telemonitoring." (Hospital doctor 3)

A GP said it was important to emphasise that telemonitoring should be used as a means to educate patients:

"If it's going to be developed in the future it's probably better to think about it as an educational tool for a patient … it might be better to promote the fact that their oxygen saturations are getting better and their heart failure is getting better because of the things they do rather than getting worse therefore call the doctor. So health promotion might be better than preventing or managing decline." (GP 3)

Another GP said that an additional area to develop in telemonitoring would be mental health:

"I think there are a lot of people with, not the mild end, but severe mental illness and I think telemonitoring would really benefit them. I think there is a missed opportunity there … people with very severe mental illness and are isolated and it is very difficult to know are they getting worse or better on a day to day basis. I think it would make a great difference." (GP 2)

Pharmacists suggested that their role could be exploited more because of their advantageous position within the community and being easily accessible by patients:

"I still have this vision that even from a pharmacy point of view, I think we should be wellness clinics, you know, and GPs are sickness clinics. So when you're sick you go to your GP and when you are well you go to your pharmacy and you get your blood pressure, your cholesterol, and all that checked to keep you well. GPs are now sort of saying 'pharmacists are a great attribute to have in our practice and to actually work with, they will do what we can't maybe do'. Like they can give us the information on blood pressure and cholesterol and that we have a bit of jointed up thinking. And I suppose this all goes towards my wellness and sickness clinic … if we are able to do a lot of the monitoring and then refer to the GPs when things are bad." (Pharmacist 8)

Health professionals agreed that telemonitoring would only be suitable for certain patients.

"There would be patients for whom it would be entirely unsuitable because they wouldn't actually understand how to do the thing and trying to take their own blood pressure might actually cause them anxiety, they might worry that they hadn't done the right thing and they weren't getting the right treatment but I think careful selection of patients would be key to that." (Pharmacist 4)

It was pointed out that targeting the right patient could include not only matters relevant to their physical and mental capacity but their environment as well.

"I've seen the brochure videos of people using telemonitoring, everything works perfectly. There's power to the house, there's no children running around, the dog hasn't chewed through the cables, you know everything is perfect but you bring that into the real world you know, urbanised poor quality housing areas where they don't have BT broadband, super fibre highway, you know when things just aren't as perfect as they seem it could run into difficulties and then who passes the buck on to who then?" (Pharmacist 7)

Hospital doctors agreed that patient selection would be crucial.

"I think it is valuable but in a select group. If the patients are young and mobile and going to work and doing other things and they don't want to be tied down to a regime suggested by a third party, the telemonitoring, in that they have to be home at 10am and ring a number and that's when they take the measurements, that's our current experience." (Hospital doctor 1).

"I'm in favour of telemonitoring continuing but I think if that's combined with trying to select those patients or groups of patients who are going to derive genuine benefit … there is some objective way of measuring or what the outcomes for that are published or in a peer reviewed journal for professionals to have a look at." (Hospital doctor 3)

"People who maybe have quite good family support and they're out and about a lot anyway probably don't get any added social benefit of coming up to the hospital and those who are maybe quite isolated and otherwise are just sitting in their houses from morning to bedtime maybe it's good for them to have, oh I've got my appointment with the doctor tomorrow and all. I don't think you can make one size fits all, can you?" (Hospital doctor 3)

This doctor said that consideration of the patient's potential anxiety or dependence on telemonitoring should be paramount:

"It's making people more aware of should their heart rate be seventy-five or should it be ninety-five or should it be sixty-five and then how disastrous is that if it strays slightly outside those limits so they maybe could get overanxious about small natural changes … maybe there's an idea to conclude the telemonitoring if they do quite well for a few months and then maybe the patient says no, no, I don't want you to take that monitoring away, I've got used to that now I couldn't do without that, so that could be a downside." (Hospital doctor 3)

Information sharing

Communication between different health professions, such as GPs and pharmacists, was said by most pharmacist interviewees to be poor:

"I have no idea which patients are on telemonitoring, we have no communication." (Pharmacist 1)

This pharmacist added that knowing which of their patients were using telemonitoring would be useful – but that lack of communication was widespread between health professions:

"It's useful to know if somebody is under telemonitoring because at least then if there is something which you're discussing, you know, you know that the person is being monitored that way, it's the lack of information and people are expecting more and more from pharmacists and people are sort of saying we should be doing this, this, this and this and unless we get information we can't do it and I have batted that for a long time." (Pharmacist 1)

Another agreed, pointing out the usefulness of information sharing: "The patient walks in and, as a pharmacist or a GP, you know what's going on with them rather than anecdotal." (Pharmacist 2)

It was also stated that information sharing could be useful to assist patients who were having difficulties with working the telemonitoring devices: "It would probably be a good thing if the pharmacist knew how it worked (telemonitoring equipment) to help anybody who was stuck." (Pharmacist 6)

Patients would also feel reassured if the pharmacist knew they were using telemonitoring, it was suggested:

"It would give great confidence to the patients that the pharmacist knew what they were doing (were on telemonitoring)." (Pharmacist 2)

An important part of information sharing and an ongoing issue for pharmacists is that they do not have access to patient electronic records, as GPs are.

"If the patient is registered the same way as our GP, they'll have more of a sense of belonging to you and they would feel more secure with the information you're sharing on them … issue of electronic records, that's one of the key things that's coming through when I attend meetings. GPs are loathe to share, even information on medicines, because we're not registered." (Pharmacist 2)

GPs also said that communication between professions could be more streamlined:

"I think more concise transfer of information. You know the more structured the more formatted correspondence from people rather than long winded letters basically." (GP 2)

"I think there's still a huge communication gap between all the various IT systems and all the clinical coding hierarchies that are used in the hospital and primary care; and even between one hospital and another; and there's not always a standard data set we get for patients coming out of hospital. So I suppose as technology advances, self-held patients' records are obviously the key to moving that forward because they are going to enforce one system that everything talks to, and again the patient then will have ownership of the data and be sort of the controller of their own data." (GP 4)

Impact on face-to-face contact

The issue of maintaining face-to-face contact with health professionals was discussed and pharmacists perceived that telemonitoring may result in less such contact. This, some believed, could have negative consequences:

"You do need be careful that you don't turn people into recluses, that they don't actually get any face contact at all, you know there's never, I don't think that there's an argument to be made that people don't need to be seen, that everything can be done remotely, you know we do need to still physically have contact with our patients on occasion, especially isolated ones." (Pharmacist 5)

"I'm a great believer in face-to-face contact and I would have fears that telemonitoring would be used as an easy way of cheapening the health service and by doing that also reducing its effectiveness. You can't tell everything over the phone, you can't make an accurate diagnosis with information given over the phone and I think you do need, a lot of the times you do need face to face contact and I'm afraid of things going in to too much of a virtual world." (Pharmacist 7)

However the importance of using telemonitoring as a means to increase knowledge about the patient's own condition and, therefore, encourage self-care and increased responsibility:

"The issue is the patient takes responsibility for their own condition, the patient monitors their own condition with objective, easy to use tests, and they make clinical decisions for their own condition based on that without the need for reference to a general practitioner or a consultant or a pharmacist. So that's the context, whether telemonitoring improves that system is really the challenge because telemonitoring only becomes effective where that system is robust … the problem is self-care hasn't been created as a robust system, it is jumping in ahead of the game, it's putting the cart before the horse." (Pharmacist 3)

"My only concern is that it could actually impinge on sort of social inclusion and it might actually create or augment the aspect of social inclusion which many elderly people would experience. It would be convenient for people who have mobility problems but the flip side of the coin is that it could impact on their social isolation or social inclusion." (Pharmacist 7)

However contact via telemonitoring and knowing that readings are being monitored was perceived by some as being better than no contact:

"If you're living on your own and you're elderly and you don't have many people calling to see you, anything is a positive. And yes, you could say face-to-face is far superior because with human beings you're engaging and, you know, it's the way we are wired so to speak. But it may be the only contact that they have during the day. It seems a better option than having no contact and I suppose the older you get the more ailments that come your way and if you feel that you are being cared for and monitored you probably feel safer, which is a good thing." (Pharmacist 9)

Hospital doctors agreed that face-to-face contact was essential and that there were wider negative implications if this was reduced.

"We need to be mindful that for some respiratory conditions the treatments are very limited so actually an awful lot of what the patient gets is doctor-patient relationship and the reassurance that they have access to a doctor because we're often not curing the condition and frequently we're not well managing the symptoms from the condition and to cut the doctor-patient relationship and the ability for the patient to build the rapport with the doctor and express their concerns and just focusing on numbers I think would be a real shame." (Hospital doctor 2)

"The face-to-face consultation can provide a therapeutic element potentially … it allows for other things to be explored. Some people might miss that opportunity if they don't see their doctor as often because of

remote monitoring the relationship may not be developed enough to allow them to maybe express sensitive issues." (Hospital doctor 1)

The value of seeing the person was also highlighted by GPs:

"If they get too caught up in numbers or readings rather than taking the clinical situation, there's the potential to miss things or be complacent … You sort of know by face-to-face whether someone is sick, if you know what I mean, rather than unwell, there's varying degrees we know by eyeballing somebody." (GP 1)

Convenience and reassurance

Convenience and reassurance were perceived as key benefits by health professionals. The benefits for patients living in rural areas and those with mobility issues were raised:

"Why would they want to travel to an outpatient appointment 80 miles away and maybe sit for an hour and a half than do something that they can actually do at home while continuing their normal day living … the rurality of Northern Ireland, that is the major advantage." (Pharmacist 2)

"A lot of these patients are maybe not able to leave their homes but you are able to actually touch base with them." (Pharmacist 8)

"I would imagine it would be extremely useful especially for patients in more rural areas or who have either mobility or transport difficulties." (Pharmacist 5)

Health professionals spoke of the reassurance they believed patients would feel from constant monitoring, as well as that which they would also have because a reassured patient tends to feel better:

"If someone is quite poorly … it probably gives them a bit of confidence … they're less stressed about their condition because they know somebody is in close proximity. When they take their oxygen SATS or whatever it is, someone at the other end of the system is looking at that regularly and they would know if there is something there and we need to sort that out and they would be on to it … most people tend to like the notion that someone has got their back." (Pharmacist 8)

"The immediate positive side that I see coming out of it is that patients maybe feel that somebody's taking an interest in them almost on a daily basis and then they find it quite reassuring and then they can go on about their day feeling a bit more confident." (Hospital doctor 3)

"I see them getting some subjective benefit, which is obviously a positive for me because I like my patients to feel that they're doing well and feeling more reassured." (Hospital doctor 3)

"It certainly engages people a little more with their health … COPD is a relatively frightening illness so if it gives them a little bit of assurance even if they are feeling not too bad, that their numbers are grand basically." (GP 2)

Impact on self-care

As the importance of healthy living is being increasingly promoted, participants said it was important for patients to take more responsibility for their own health:

"I think it empowers the person that with any luck they will take an increased responsibility for their own care and ownership of the situation they're in." (Pharmacist 9)

"I think everybody, the population in general, need to become more invested in looking after their own health and trying to prevent becoming sick in the first place and trying to treat yourself once you get there." (Pharmacist 5)

"It would give them more awareness and ownership of a condition, the problem with society today is that people are often too willing to let everybody else take ownership of their health and it's always somebody else's problem, let somebody else deal with it and I'll get on with my life thank you very much but you know you do all the work and I'll just sit on the sofa here and watch Jeremy Kyle." (Pharmacist 7)

While GPs were overall sceptical that telemonitoring would result in significant health improvement, they believed that it could enable greater self-care and education.

"It involves the patients more in their illness, it gives them a better understanding through taking their readings and I think through that they know, without even being prompted, how to get help for their conditions … I think it also gives them targets to reach too because you get people who take real pride in their numbers." (GP 1)

"I think it puts the patients a bit more in charge of their health and it provides reassurance for them, but it mainly engages them a bit more in the whole healthy lifestyle and engages them in taking responsibility for their own health." (GP 2)

Impact on healthcare professionals

Telemonitoring was reported to impact on healthcare professionals in terms of their workload, patterns of working and use of information.

Participants said they believed their workload may be reduced with increased use of telemonitoring:

"I suppose the most useful thing is to reduce the consultation rate, to basically take the pressure off the system." (Hospital doctor 1)

A GP said that an increase in his workload would not necessarily be a bad thing:

"My feeling would be that it would inevitably increase my workload … if it was appropriate that wouldn't be a problem because it might reduce it somewhere else down the line. You might catch somebody early and the decline of a condition that you can do something about before things amount to having to be out two or three times." (GP 3)

However another GP cautioned that actually seeing patients face-to-face and getting to know them in itself eases workload:

"Once you know somebody you're more likely to take them at their word, you know the people who are worrying, whenever they worry you should worry, and you know the people who are always worrying and there's nothing wrong there. So I think rapport is one of the foundations of general practice that we have over the hospital specialities and I think that knowing patients actually reduces our workload in a way." (GP 1)

Health professionals were asked if they would welcome the opportunity to see the data sent by patients to the telemonitoring triage nurses.

"More data is always good I think, particularly in our area. Blood pressure is particularly an important area because of repeated measurements are very helpful and the national guidelines would encourage that." (Hospital doctor 1)

"As yet nobody (patient) has come in with a print-out and said this is what it's (oxygen saturation) been like over the last month or can I send these in to you every month so you can have a look over them so yes, I probably wouldn't welcome getting them sent in to me but I'm not saying that I'm not interested but I presume somebody is looking at them and therefore unless there is some unusual trend happening that they want consultant input on I'm probably happy to leave those people to do it." (Hospital doctor 3)

"I don't know whether I would have time to look at it, that's the problem. I mean I'm inundated with information now. So the prospect of getting more information and more results from people just fills me with dread, to tell you the truth." (GP 2)

Concerns about telemonitoring

There was some hesitation in accepting telemonitoring without a stronger evidence base, and concerns over costs.

Doctors called for some published evidence of the effect of telemonitoring before the system was developed:

"I would be interested in evidence in terms of objective outcomes." (Hospital doctor 3)

"I would love to see the evidence base to say that it prevents readmission or improves overall health outcomes for people." (GP 2)

"If it reduced admissions to hospital for individual patients that's probably one tangible benefit that you could measure. It's not really designed to improve their health, it's designed to trigger when they're bad so the health improvement would come from people actually going to see them and checking them and educating them and trying to change some of the things that they do." (GP 3)

A GP said that the high cost he believed was involved in telemonitoring could be diverted elsewhere in the health service:

"I think it's an expensive way of doing what it does. It requires infrastructure behind it to keep everybody right, you're adding a third layer into the care, you're adding the people who monitor the telemonitoring, they don't do anything other than pass on their request, they're well qualified nurses, would it not be better if they were actually directly going to somebody who knew what the condition was and what was happening and how to do something rather than just pass on the information?" (GP 3)

A pharmacist suggested that real benefit may not result from telemonitoring:

"Disadvantages are inappropriate use, very high cost and potentially no benefit because the patients are incapable of making decisions which will influence clinical changes to bringing round better outcomes." (Pharmacist 3)

This participant said that alternatives could be more effective:

"The alternatives in terms of supporting the expert patient programmes I think is probably a more appropriate way of doing this, making sure the patients are actually very well educated about their conditions. That's not saying that can happen without telemonitoring, telemonitoring is a little bit too specific, it's going to be part of a wider evolving change in the way that health services support and manage patients' long term conditions." (Pharmacist 3)

5.4.4(b) Health professionals engaged directly with telemonitoring (triage nurses /telehealth key workers/service development managers)

Information sharing

Participants agreed that shared information was very useful. Triage nurses suggested that telehealth key workers should share more details on their patients:

"We don't get a lot of information on medical history … it's quite frustrating that we're not told what stage their COPD is at so we don't know any of their pulmonary function results because that can help us … obviously the more you know about the patient the more you can make a decision on them." (Triage nurse 2)

"When we have escalated patients (to be followed up by specialist nurses) there is never a follow-up to say this lady is discharged … we don't know what decisions have been made." (Triage nurse 3)

"A lot of them (specialist nurses) don't update their records … if we have a patient that hasn't sent in a reading our process is that we try to ring them three times and if we don't get a reply we ring the telehealth key worker and then she'll say oh she went into hospital yesterday afternoon, we could have been saved three calls if a note had been put on there." (Triage nurse 5)

Telehealth key workers said that the information available from telemonitoring was useful when they needed to share it with other professionals:

"I do find it really useful … when you're trying to build up the evidence and provide that to GPs and get a case that the patient's blood pressure tablets should be increased or even started. The reports that you can print out and send to the GP are excellent because they look quite professional." (Telehealth key worker 7)

Responsiveness in the delivery of care

Triage nurses spoke of the unique advantage their position offered because with constant monitoring they can escalate care for a patient if necessary:

"We're recognising the symptoms of chest infections and we're acting on them quickly whereas probably in the past people have said I don't want to bother my doctor … now they know that we've heard and you're better to get treated now before it gets a hold of you and I think is has shown that their admissions have been reduced as well." (Triage nurse 4)

"If there are early discharges from hospital the patient can have the system set up and it means that a close watch is kept on their progress The GPs can have access to that as well and it makes the patient more confident about their medical condition." Triage nurse 5)

"People with these conditions don't want to be in hospital all the time and from that perspective it's totally invaluable." (Triage nurse 7)

Accurate readings were said to be a significant advantage of telemonitoring:

"Some of our diabetic nurses would tell you that clients will tell you what you want to hear so when you say what's your blood glucose doing over the last week, 'oh it's been great, it's been within the normal range' and maybe without seeing that visually you take that as correct whereas this way they're able to go into the system and see exactly the dips and the highs and can pinpoint at an early stage if somebody needs treatment." (Service development manager 3)

Another manager said that the aim of telemonitoring was to educate the patient and to enable them to develop enough confidence in managing their own condition that they are not as reliant on professionals:

"A success story would be when they get to the end of their time in telehealth and they've got a better handle on their condition that they actually don't need to see the professional as much, to me that is the end goal." (Service development manager 6)

A major challenge for telemonitoring was mentioned by a number of service development managers as that of dealing with patients with co-morbidities.

"We struggle within the service to manage co-morbidities … we sort of work around the systems as opposed to having a clear way of managing them." (Service development manager 4)

"So if I have COPD and I also have heart failure and diabetes … if I'm on the system already for COPD you can't refer me to the service for diabetes. That's a big limitation." (Service development manager 1)

Professionals said that telemonitoring should ease workload:

"It identifies worsening symptoms quicker, maybe it gives us early warning signs that the patient is going into exacerbation and it does try and prevent hospital admissions and promote self-management." (Telehealth key worker 4).
Asked if she had seen patients who had been prevented from going into hospital, this key worker said: "Definitely."

However one key worker said that the service had actually increased her workload:

"We found telemonitoring time consuming because we had to take time out of our day to go in and look at the readings, didn't always get the patient, left messages, they weren't always returned so we were chasing patients …" (Telehealth key worker 3)

Reassurance and Support

As everyone agreed, reassurance and support for patients and their families was said to be a major benefit of telemonitoring:

"The patients themselves say it gives them great reassurance and a backup that they have that they know there is somebody clinical looking at that every day and if there is any difficulty we will contact their specialist nurse." (Triage nurse 1)

"The patients get a lot of reassurance out of it knowing that their readings are being checked on a daily basis and if there were any alerts they know we would contact them." (Triage nurse 2)

"The families … would say that it gives them reassurance if maybe they are out at work and they know that somebody will contact their mum or dad if there is the slightest thing wrong." (Triage nurse 1)

With reassurance came confidence, and this was widely spoken of among health professionals.

"The great strength is informing and educating patients to recognise their triggers … it puts a bit of the responsibility back on to the actual person with the illness and it gives them a bit of confidence maybe to remain at home where previously they might have been in hospital." (Service development manager 4)

"Patients mostly feel very reassured that somebody is keeping an eye on them closely. Because they've had their blood pressure monitored about four times a day in hospital and then they come out and nobody's maybe checked it for a week and we go out and it's high and they think 'Oh my goodness'. So it's nice to be able to offer that." (Telehealth key worker 7)

Health professionals were also said to feel reassured knowing that their patients were under constant monitoring:

"It's wonderful, it can offer a great assurance to professionals in terms on ongoing monitoring of the patient's condition and particularly those people with long term conditions." (Service development manager 2)

"For families, sometimes they would have phoned in looking if blood pressure or oxygen saturation is checked and this gives them some peace of mind." (Telehealth key worker 4)

All participants spoke about the support which patients experienced from telemonitoring.

"Some of the patients, they like this part of their routine now, They know they have to do their observations and they know if something is wrong we'll be ringing straight out to them." (Triage nurse 3)

"The fact that some of them are on their own and you can speak to them … you can tell a lot on the phone, you can tell if they're short of breath, if they're wheezy, if they can talk to you in a sentence or not. You can really find out a lot that way." (Triage nurse 4)

Some triage nurses reported that there have been occasions when they were able to phone an ambulance and arrange emergency care for a patient, whereas if the patient did not have telemonitoring this would not have happened.

"On quite a few occasions we've had to phone 999 because they have been so unwell … you ask the usual questions – their colour, their breathing, their pallor, and then if they would like us to phone an ambulance if there is no-one else in the house. In these cases we would have two members of the team involved – one would talk to the patient and keep them on the line, reassure them, and the other would phone the ambulance." (Triage nurse 6)

"The respiratory and heart failure teams on the ground say it's invaluable in that it provides a lot of reassurance and reduces anxiety, and that in itself helps the condition." (Triage nurse 7)

Most telehealth key workers agreed that the service was supportive to patients, whatever condition they had.

"The women (with maternal obesity) do find it very helpful, very beneficial that the (weighing) scales are provided for them and it's a weekly thing and they can keep an eye on their weight. When they see their weight in front of them, when it's within the guidelines they find that really helpful and I think it spurs them on a bit." (Telehealth key worker 5)

"We're quite used to having it now and it certainly is a tool that supports and gives the patient more support than what we can give just being sole people." (Telehealth key worker 6)

Communicating with patients

Triage nurses spoke of the new skills they developed because of communicating with patients solely by telephone:

"As a nurse you're used to observing them … but it is amazing how quickly you can pick things up on the phone and how you do have a relationship with them and you get to know them because it is the same people, generally it's the same people who alert every day really so you do build up a great rapport with them." (Triage nurse 1)

"You have to hone your listening skills, really assessing the patient because sometimes they say oh I'm ok or whatever but you use your intuition skills speaking over the phone." (Triage nurse 3)

A specialist nurse said that patients did not mind having less face to face contact because of the opportunity to talk to triage nurses at any time.

"They're happy that there's someone at the end of the phone, they often say 'I'm just so glad I can phone somebody' or 'those girls at telehealth are lovely, they're really helpful'." (Telehealth key worker 6)

Everyone agreed that patient selection was crucial to successful telemonitoring, and communication was central to this in terms of identifying the right people:

"If the patient is uptight, very uptight to start off with it's not suitable, or if they're extremely old or hard of hearing … but I've really been surprised, some of the older people you thought wouldn't cope with it do. But hearing is definitely, you know they have to be able to hear you." (Triage nurse 4)

"You need to be patient specific. It's not for all patients. You don't want to put it into a patient's home and then have it a) annoying or causing frustration or anxiety to the patient, or b) you don't want to put it into someone's home that they can't use it and get the benefit of it." (Service development manager 1)
"We find with very anxious people it doesn't tend to, it sometimes makes them more anxious about checking their oxygen and what not. If I think they need a break from it I'll prompt them to take a break because there's some people that depend on it but they self-manage very well, there's other people depend on it but they're still not self-managing and I think that's the type of people that it's not doing any benefit for." (Telehealth key worker 6)

Convenience for patients and professionals

Some participants spoke of the convenience for health professionals that telemonitoring offered:

"It think it's fantastic as well for track and trend patients because if you take diabetes, the specialist nurses and doctors don't actually have to bring these patients into clinics to review their blood sugars and their trends, they can see them right there. Contact the patients, make adjustments and then review them again, it's fantastic really." (Triage nurse 2)

"Rural areas, the patient would be quite far out from their GP and nurses at least, especially in the winter time, when the readings are done the specialist nurse can have a look and if by any chance she's not able to actually visit them she can see what the readings are like and assess them over the phone and deal with it at a distance." (Triage nurse 5)

A service development manager said benefits to both professionals and individual patients had occurred in his area:

"By putting telemonitoring into a client's home our diabetes nurses were able to reduce the number of clinics and were able to remote monitor the patients and prevent the patient having to drive to the clinic. For an elderly patient to have to arrange to come to a clinic they may need a lift from their son or daughter or neighbour; their son or daughter or neighbour may need a child minder to look after their children, so there's a whole knock-on effect." (Service development manager 1)

"Sometimes you can pre-empt rather than, we would have gone out and done a lot of proactive visits, sometimes we don't have to do that now, we're not going out on the one errand to check an oxygen saturation or blood pressure, the monitor will do that and alert us." (Telehealth key worker 4)

"You don't have to waste that time travelling out to the patient's home to get a blood pressure. And a post like mine where the geographical spread of everybody is very wide then that's a big benefit." (Telehealth key worker 7)

A manager pointed out that travel difficulties were not restricted to rural areas:

"We are particularly affected by that (rural areas) here and it's extreme. But I met with a community group of older ladies in (town) and they were saying that even to get to see their doctor, their mobility wasn't as good as it used to be and particularly in the winter, if it is icy they were worried about coming out of the house, and then if they had to get a taxi, the cost of that." (Service development manager 2)

"They don't have to go to a treatment room, they don't have somebody like me interrupting their daily routine and coming into their home." (Telehealth key worker 7)

It was pointed out, however that specialist nurses were still under pressure from handling alerts created from telemonitoring on top of their general work:

"Sometimes if we get too many alerts it's an inconvenience for the clinicians … that's tied in with parameters and getting them right at the outset. But ultimately if they've got what I call scheduled work, in other words booked appointments and patients to see, this (alerts) creates unscheduled work, it creates a demand that they need to be able to respond to in addition to what they've planned to do." (Service development manager 6)

A service development manager said that a significant inconvenience for health professionals was the lengthy referral form.

"The referral form is a big disadvantage and we've talking about trying to get a shortened version; if clinicians didn't have to spend 15, 20 minutes (completing the form) it might lend itself to more referrals coming on board." (Service development manager 4)

A specialist nurse agreed: "The referral itself is quite lengthy and bit of it are a bit repetitive … they were going to look at reducing the number of screens." (Telehealth key worker 5)

There were some concerns about telemonitoring. A number of service development managers reported that some health professionals were not positive about adopting telemonitoring when it was first suggested.

"At the very start whenever I was working to implement the project there was quite a lot of resistance … I think it was around a fear of change … the main selling point to me is that it's something else that clinicians can use to support them in the best care that they want to deliver for their service users." (Service development manager 5)

"Despite numerous attempts at getting GP involvement, we struggle to get any of them really brought into and being champions for the service … I would have thought it would have cut down the face to face contact, they're still getting the vital signs and they're still getting the readings, they can have a consultation over the telephone if need be, so the way I was trying to sell it to the GPs was nearly like a virtual clinic." (Service development manager 4)

"If it all went away tomorrow it probably wouldn't make a huge amount of difference ... I have a caseload of about 230 patients and I have 17 on telemonitoring." (Telehealth key worker 2)

Empowering patients

Professionals said they had witnessed an improvement in self-care among patients using telemonitoring:

"It does seem to be teaching them to be better self-managers of their condition and you know even the oldest patients, of 90, it is amazing just how they then catch on we well and they will know if their oxygen levels are down slightly that day or maybe I should take it a bit easier today." (Triage nurse 1)

"Most of them know if their oxygen level goes below a certain level, they know to either take less exercise, relax, do their deep breathing exercises, use their oxygen more or use their ventilator. So they know a lot about their conditions and they could teach us a thing or two." (Triage nurse 5)

"It's empowering your patient giving your patient the information to make them a bit more self-managing … they're told to look out for signs and symptoms of their condition where previously they would have just relied on the nurse to, say, call out and see me again on Friday." (Service development manager 4)

"The specialist nurses have more empowered patients, they're maybe not having to see their patient as frequently as the patient becomes more self-aware, self-managing in relation to their condition. There was a heart failure client who would have been a frequent patient in and out of the hospital, frequent admissions throughout the year, since deploying the remote telemonitoring it has, and staff within heart failure would say that has prevent admissions to hospital on numerous occasions because he knows now to directly go to the staff and say 'look my SATS are up or down, my SATS are low and my sputum is quite green and I think I'm getting a chest infection' so then they can point him in the direction of the GP and get him started

on an antibiotic and he's at home throughout all that experience as opposed to having to be admitted." (Service development manager 3)

While most health professionals, including telehealth key workers, agreed that telemonitoring fostered an improvement in self-care, a couple of specialist nurses said they had found the opposite:

"Insofar as they still don't have any insight into their condition and it doesn't encourage them to have any insight because they are relying on the monitor picking everything up. I know it's designed to promote self-management but I think in those circumstances it probably does the opposite." (Telehealth key worker 2)

"When we were first told about it (telemonitoring) we were very against it in that it de-skills the patient, it strips the patient of their responsibility of looking after themselves. Our aim is to try and get patients to take the initiative and responsibility of looking after themselves, checking their blood sugars and contacting us for advice. With telehealth they waited for us to phone them." (Telehealth key worker 3)

However, there were some concerns about how telemonitoring could lead to an element of dependency in patients.

"You find that if the patient is on the service for months upon months, they can become reliant, or mentally reliant on the service we'll say, and when you go to try to remove that service in a lot of cases they don't like that idea." (Service development manager 1)

"Once you put it (telemonitoring) in for these patients, even if it's meant to be just a small amount of intervention for them, it can be very difficult to get it out again … these are probably the more anxious patients anyway you start to suggest that you are taking this layer of monitoring away and they're really very reluctant to give it up." (Telehealth key worker 2)

Resources

Resources were an important consideration in terms of both equipment and appropriate use of manpower.

Participants spoke of difficulties with equipment, either as a result of instruments giving inaccurate readings or battery operated monitors.

"There are a lot of problems I feel with the temperature probes and the SPO2 probes." (Triage nurse 1)

"If more time was allocated (for the engineers) to spend in the patient's home so that they are more confident and that maybe they can send through two or three sets of readings so that everybody is sure what they're doing that would be a great benefit really." (Triage nurse 1)

"The equipment is quite outdated, there seems to be a lot of maintenance carried out." (Triage nurse 3)

However some professionals pointed out the advantages to be gained from the technology:

"Maybe once a week I would go in (to the system) and review their weights … you can access that information and it's quite useful … I'm just looking to see a bit of a trend, you can put everything in graph or table form which sometimes can be useful to print off." (Telehealth key worker 2)

"I would hate to see it go because it is a tool to monitor and you know what's happening, and especially if you've been out with somebody and they've started on antibiotics, steroids and maybe haven't been that well, you can look tomorrow (in the system) and see if there are any improvements in their oxygen levels." (Telehealth key worker 6)

Consistent with the comment from GP 3 that the highly qualified triage nurses could be used in better way, the nurses themselves agreed:

"With the track and trend, the diabetes and stroke, we don't really have an input in that so we're just ensuring that their readings are coming through. I think as nurses it's not really a satisfying role, anybody could do that, if could be done at a call centre with no clinical qualifications ... I just think sometimes your clinical skills are wasted on that (track and trend)." (Triage nurse 1)

"Working in acute care you're very proactive with health promotion and keeping them well … I found that quite difficult when I went to telehealth because we're not allowed to give them any advice, we're not meant to ask questions about what medication they're on … I found that very frustrating." (Triage nurse 2).

When asked about further developments for telemonitoring, a number of participants raised the possibility of video consultations, more health promotion and new observations to be monitored:

"I think it (Skype) would be a good idea … just to see them, you can see their colour and maybe count their respiratory rate and generally do they look well." (Triage nurse 2)

"We're supposed to do proactive management … there's a lot of people down the line who are in their 30s, 40s, 50s and really should be using this to get a better understanding of their illness earlier. I mean we're getting them whenever they're over 65 and they're in the palliative stage of COPD so there could be a lot of work done with practice nurses and nurse practitioners in GP surgeries." (Telehealth key worker 4)

"For my patients I get a blood pressure reading and a heart rate and it would be fantastic if the system could pick up any irregularities in the heart rate … I don't know how feasible that is." (Telehealth key worker 7)

6. General discussion

The research team have attempted to ensure that the methodology and main findings are presented in a coherent and logical sequence to allow the reader to fully understand what was measured, how it was measured and the results of the various measurements made. Results in the main body of the document are supplemented with additional data tables (as a series of appendices) to allow interested readers to gain more detailed information on topics of interest. The project was complex with broad aims and objectives. Rather than revisiting the findings, section by section, this general discussion focuses on what the research team consider the most important aspects and findings of the overall research programme. It highlights those findings which have been seen for the first time because of this evaluation.

6.1 Methodology used

The programme of work used a mixed methods approach, involving surveys, the interrogation of existing and linked administrative databases, and qualitative approaches (focus groups and interviews) as is current best practice in this type of research, but which also brings some challenges. The greatest challenge was gaining approvals to retrieve, link and use datasets which were owned by the HSC Trusts and held by TF3. The procedures for gaining such access were new and initially considerably slowed progress with the research. Once this hurdle was cleared, and following data cleaning, data analysis was reasonably straight forward within the HBS, whose staff were very supportive. The data structures, however, prevented access to the exact data desired for some of the analyses and the delays and lower than expected number of referrals in mid-2015 also caused problems. In particular, the research team had intended evaluating a prospective cohort of patients who had newly enrolled on to the monitoring programme, but, as detailed in section 4.2.1b, this did not prove possible because only eight recently installed telehealth users volunteered to join this proposed study.

6.2 Descriptive analysis

The data within the descriptive analyses covered the complete programme of implementation of the telehealth service from the original start date of December 2011, for all conditions, not just those that are the focus of other parts of this report. There was a steady stream of installations over the period (ranging from 110 to 426 installations per quarter; mean per quarter 248). This is a very impressive roll-out of a new, complex service requiring very considerable administration and management. Engagement was good across all Trusts, but with varying patterns in relation to the types of patient who were referred. The NHSCT referred particularly high numbers of patients (n=1228). The BHSCT has the lowest number of referrals (n=456) perhaps linked to the more urban based population within this Trust. Different Trusts appeared to focus on different conditions with, for example, weight management being particularly popular in the NHSCT, while diabetes monitoring was particularly common in the SEHSCT and the WHSCT. The SEHSCT also had the highest number of referrals for COPD. The distribution of patients across Trusts for the four targeted conditions (heart failure, COPD, diabetes and hypertension) was variable. The number of patients receiving the hypertension ‘package’ (the majority were within the NHSCT) was much lower than

for the other conditions, although blood pressure monitoring formed part of other disease specific packages. COPD and diabetes were the two of the four targeted conditions that were most frequently monitored. Patients engaged in telehealth monitoring were distributed across all age groups (from 0-19 to 80-99 years), with weight management featuring more frequently in the younger age groupings and COPD and heart failure featuring more prominently in older patients. Diabetes care was distributed across all age groups. A good mix of male and female patients were involved, albeit with a slightly higher proportion of females participating in the programme, driven primarily by younger females engaged in weight management programmes. The majority of patients were referred only once to the service with only 254 patients referred more than once. The majority (3826) of those using the telehealth service were reported as not having been given any education package – this will be referred to later in the short list of recommendations (Section 7). When the distribution of patients was examined against measures of deprivation, there was a good spread across all deciles of the Multiple Deprivation Measure (MDM) and the subscale for proximity to services. As expected, due to the link between high deprivation and poor health, there was an under-representation of patients within the least deprived deciles for both scales (MDM and proximity to services subscale).

6.3 Study results

6.3.1 View of patients, carers and healthcare professionals on the telehealth programme

Although the final experimental section in the main body of the report focuses on the views and experiences of patients and carers who used the telehealth service, and healthcare professionals who are either delivering or who may be involved in delivering services to patients in the future, we discuss these findings first here because of their importance within a patient centred care environment.

Support for the telehealth service was overwhelmingly positive, particularly from patients (and their carers) who used the service. Healthcare professionals were generally positive, but much more guarded, particularly those who had little or no direct experience of the service. Our findings agree with the general conclusions of other studies in the literature.

Reassurance was a major theme throughout patient and carer interviews and focus groups. Many said that feeling reassured that a health professional was monitoring their condition allowed them to carry on with as normal a life as possible. This was a common view among patients with all conditions. It is consistent with a qualitative study of heart failure patients using telemonitoring by Fairbrother *et al.* (2014), which also identified reassurance as an important theme. In the current evaluation, doctors pointed out how reassurance and reduced anxiety was good for patients' health.

Patients, particularly those with COPD, said that another major benefit of telemonitoring was 'keeping them out of hospital,' and some reported having fewer hospital stays since receiving the service – they were understandably very keen to continue using telemonitoring. A Cochrane Review (McLean *et al*.,

2012) examined 10 randomised controlled trials which assessed the effectiveness of telehealth among COPD patients compared to face-to-face care and found that telehealth had a positive impact on the quality of life of patients and the number of times patients visited hospital.

Patients feeling secure, reassured and better educated has been reported widely (including Dinesen *et al.,* 2013; Gale and Sultan, 2013; Riley *et al.*, 2013; Odeh *et al.,* 2014; Williams *et al.,* 2014).

Healthcare professionals and patients reported that telemonitoring data had assisted in medical treatment decision and diabetes patients noted that the service had encouraged maintenance of a healthy diet. The latter was also noted by Hanley *et al*. (2015) in a study of 23 diabetes patients who used telemonitoring for measuring blood glucose and blood pressure control.

Odeh *et al.* (2014) reported that general practice nurses involved in implementing telemonitoring found their workload had increased; we also reported an increase in workload, however, we also found that some health professionals' workload was eased as a result of the service.

Patient selection was highlighted as a crucial factor in successful telemonitoring. Health professionals and carers noted that patients' parameters, i.e. the range within which observations are deemed normal, must be individualised. Telemonitoring seemed to be less favoured among younger, more active patients, and those whose condition was well-managed and under control, and for whom it was less convenient to be at home at a stipulated time to take and upload readings. It was considered ideal, however, by and for those needing to stabilise their condition, those who were less mobile and less able to travel, and those who benefitted most from the reassurance that the service provided. Fairbrother *et al.* (2012) interviewed 18 patients and five professionals involved in a telehealth service monitoring heart failure and reported that the professionals advised that a targeted approach to patient selection was necessary.

Healthcare professionals pointed to the potential problem of patients becoming dependent on telemonitoring, again highlighting the need for careful patient selection and review. Some patients acknowledged that they relied on the service and fought against its discontinuation from their programme of care, arguing that it had prevented their need for hospitalisation or repeated clinic visits.

While health professionals tended to identify difficulties with the equipment, including that it needed updating, patients had contrasting views. The fact that the monitoring devices were simple to use was considered by patients to be of significant benefit, particularly for patients with serious illnesses for whom dealing with more complicated technology may have stressful. Healthcare professionals suggested new approaches which could be added to existing services, such as video consultations, but patients were generally satisfied with the current approach saying that improvements and upgrades were not needed. One patient who was discharged early as 'unsuccessful' did, however, report becoming stressed and frustrated when she was unable to get blood sugar levels uploaded on to the system.

Alongside their more guarded support for telemonitoring, healthcare professionals expressed their view that they wished to see more evidence of effectiveness. A number also expressed their view on the importance of face-to-face contact with patients and that robust self-care approaches involves much more than monitoring. The expense of the service and the anxiety that could be caused when the service is discontinued for a particular patient were also raised. Generally healthcare professionals who were not directly engaged with the service felt that much better systems of communication and information sharing were required. A more minor point was that healthcare professionals who were involved with the service found the referral documentation cumbersome and time consuming to complete.

6.3.2 Quantitative assessments

(a) Self-care study

The response rate was lower than anticipated from the group of patients who had received or were receiving this new and innovative service for the four targeted conditions; this limited the research team's ability to compare and contrast the findings across different types of patient or with other studies. Nonetheless, the 206 survey forms returned were in general well completed, demonstrating good engagement of those who participated. As expected, health related quality of life was lowest in patients with COPD and heart failure, with higher scores being obtained in patients with diabetes and hypertension. Review of literature values for health related quality of life in the target disease groups indicated that the present telehealth cohorts had values either similar to or lower than published mean values, indicating that the case mix of patients involved was at the more serious end of the disease spectrum. The breakdown of data on the frequency of reported problems by dimension of the EQ-5D-5L scale highlights the type of problems still being experienced by patients. Of particular interest is the numbers of patients who reported suffering from moderate (or above) anxiety and depression within the COPD group. This highlights a target for intervention in future services.

General self-efficacy scores mirrored those for health related quality of life, with higher self-efficacy scores noted in patients with hypertension and diabetes. Disease specific self-efficacy was slightly higher for the present cohort, when compared with the published norm for COPD patients, but slightly lower in the cases of diabetes and heart failure, i.e. no consistent evidence that self-efficacy (and therefore self-care) was enhanced through use of the service in this point prevalence study. Case mix will of course influence these results, but could not be accounted for within this dataset. In a similar vein to the anxiety and depression in COPD patients, it was clear from the results for hypertension patients that self-care adherence to low salt diets and weight management was poor, again creating targets for future monitoring services.

When the quality of life scores and general self-efficacy scores were examined across the different categories of patients of 'not successful', 'successful', 'discharged' and 'ongoing', the data were very similar across all groups indicating that within this cohort of patients, health related quality of life and general self-efficacy were relatively stable and not influenced by the telehealth service provision.

(b) Effectiveness study

By far the most marked finding within this part of the overall evaluation was the finding of a higher mortality rate (33.3%) within the quasi-control, 'Never installed' group compared with the 'Installed' group (13.9%). This was a striking finding, particularly within the COPD and the heart failure groups. The Kaplan-Meier plots showed a marked level of mortality within the first year since referral in the 'Never installed' group. Although tempting to infer that the results are indicative of the alerts generated by telehealth monitoring facilitating the early implementation of life saving interventions, it is likely that at least some of these patients did not have equipment installed because they had become morbidly unwell. Decreased mortality due to telemonitoring has, however, also been demonstrated by Dendale *et al.* (2012) in a study involving telemonitoring in a group of 160 patients with heart failure, but this was not reflected in a larger study (Chaudhry et al., 2010). Decreased mortality has also been demonstrated in the Whole Systems Demonstrator Project (Steventon et al., 2012), the largest controlled clinical trial to date on telemonitoring. In the latter study, there were also decreases in the number of elective admissions, outpatient visits and emergency department visits, but these decreases failed to reach statistical significance. Interestingly quality of life and psychological outcomes were not improved in the latter study through the provision of telemonitoring (Cartwright *et al*., 2013).

Although there were a number of testimonials from the participants in the patient focus groups regarding reduced hospitalisations and a reduced need to attend outpatient clinics, this did not carry through to the data obtained in the effectiveness aspect of the current evaluation. In general terms, the number of hospitalisations, length of hospital stay and outpatient clinic attendance (and therefore overall cost of healthcare provision) did not differ between the quasi-control 'never installed' group and any of the groups who received some amount of telemonitoring. The results, where they were statistically significant, were largely driven by an anomalous result for the heart failure 'never installed' group. This lack of positive findings regarding a beneficial impact of telehealth services on healthcare resources was disappointing, however, should not overshadow the positive impact on mortality.

In summary, the main impact of the telehealth service according to the objective findings in this evaluation is on mortality, while in subjective terms it is on peace of mind for the recipients of the service. The main limitation of the research is that the work evaluated a service that was already up and running without a robust control group and largely depended on routine administrative information rather than data collected to standards generally put in place for research purposes, and as such the strength of the evidence is compromised. A further limitation was the lack of availability of primary care health utilisation data. Nonetheless the work does allow the development of a number of recommendations regarding the continuation and further development of the service and these are summarised in Section 7 below.

7. Recommendations

Recommendations regarding service quality improvement are as follows:

1. Engage other health care professionals (including GPs and community pharmacists) through improved information flows.
2. Evolve the intervention within a complex intervention framework (rather than simply self-monitoring) with formal education provision on disease state, medication management, management of anxiety and depression, and self-management of symptoms.
3. Collect data alongside the delivery of the programme that could be used for research purposes with minimal disruption to the delivery of the service, such as that needed to undertake an interrupted time series analysis. Patients on enrolment could be asked to provide written consent that their data could be used for research purposes. If the service is oversubscribed, patients could be randomly allocated to the service, and as such a robust control group would naturally be in place for further service evaluation.
4. Develop strict rules for patient selection for inclusion in the service, including how co-morbidity is addressed (perhaps using simpler referral documentation).
5. Develop strict rules for withdrawal from the service, making these clear to patients from the outset.
6. Consider the lessons learned about the use of the routine administrative data and its linking to data held by the Honest Broker Service in any future discussions of how these data are stored and accessed in order to facilitate future evaluations of this type.

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List of Appendices

Appendix 1: Inclusion criteria for the five patient types

(i) Never installed (control):

- There will be no ***reason for discharge*** variable.
- Referred to the telehealth service but never installed, even if re-referred.
- Shall have one of the study's four target conditions.

There were a total of 114 people identified in the not installed group of patients, of whom 33 were deceased.

(ii) Successful:

- Check the variable Reason for discharge and include only those which read: "Outcome achieved."
- If there is no "reason for discharge" then omit from sample as it cannot be determined whether they were successful or not successful.
- Referred and installed.
- Disregard time spent on the service, i.e. they may have a successful outcome even if they did not spend the full time on the service as proposed at the time of referral and vice versa.
- Shall have one of the study's four target conditions.

There were a total of 580 people identified within the successful group of patients, of whom 104 were deceased.

(iii) Not successful:

- Check the variable ***Reason for discharge*** and include those with the following reasons:
  - Family declined service,
  - Patient declined service,
  - Non-compliance with service,
  - Outcome not achieved and
  - Other (inappropriate referral-only keep if referred once only, poor internet connectivity in area or inability to understand how to use monitoring equipment).
- If there is no "reason for discharge" then omit from sample as it cannot be determined whether they were successful or not successful (these will be covered in the additional patient type groups: iv and v).
- Referred and installed.
- As for the "successful" patient group, disregard time spent on the service.
- Shall have one of the study's four target conditions.

  There were a total of 251 people identified in the not successful group of patients, of whom 66 were deceased.

In addition to the original three patient types (never installed, not successful and successful), two further groups of patient were added to ensure representation and coverage of those with the four target conditions using telehealth services. This included those who had been discharged and those who were still on the service (i.e. had not been discharged), however, in both cases they had no ***Reason for discharge*** listed. The following criteria for these additional two groups was as follows:

(iv) Discharged, no reason for discharge listed:

- There will be no reason for discharge variable.
- Referred and installed on the telehealth service and have been discharged.
- May have been on the service for a shorter or longer period of time than was proposed at the time of referral.
- Shall have one of the study's four target conditions.

There were a total of 299 people identified in the discharged group of patients, of whom 78 were deceased.

(v) Ongoing:

- There will be no reason for discharge variable (they have not been discharged).
- Referred, installed and remain on the telehealth service.
- Shall have one of the study's four target conditions.

There were a total of 742 people identified in the ongoing group of patients, of whom fewer than 10 were deceased.

Appendix 2: Required permissions

Ethical approval was sought from the NHS REC (submitted 22 December 2014) and was given a favourable opinion on 14 January 2015 (15/SW/0015). Trust Governance in all five HSC Trusts was applied for from 5 to 17 February 2015. Approval was received for these on 26 February 2015 (earliest) and 24 April 2015 (latest). These approvals were required to be in place before Data Access Agreements (DAAs) could be approved from all five Trust Information Governance (TIG) teams. It was determined that two separate DAAs were required. The first agreement (DAA 1: submitted 03 March 2015) was to allow Fold to send out information packs on behalf of the research team at QUB to eligible patients in relation to the questionnaire studies and also for interviews. The second (DAA 2: submitted 10 March 2015) was submitted to enable data extraction, secure transfer to BSO ITS and finally for the HBS to hold the anonymised dataset to enable access by researchers. This was a lengthy process, the earliest signed DAAs was received by QUB on 20 April 2015 and the last on 14 July 2015 (Please see Tables 2.1 and 2.2).

Table 2.1: DAA1: request for permission for TF3 to contact patients on behalf of QUB.

	Submitted to Information Governance	Signed Approval (date as per signed document)	Received by QUB research team.
BHSCT	03 March 2015	21 April 2015	22 April 2015
NHSCT	03 March 2015	24 April 2015	07 May 2015
SEHSCT	03 March 2015	08 July 2015	14 July 2015
SHSCT	03 March 2015	14 April 2015	28 April 2015
WHSCT	03 March 2015	18 April 2015	20 April 2015

Table 2.2: DAA2: request for permission for TF3 to provide HBS with a dataset relating to the telehealth service provision in NI.

	Submitted to Information Governance	Signed Approval (date as per signed document)	Received by QUB research team.
BHSCT	10 March 2015	21 April 2015	22 April 2015
NHSCT	10 March 2015	24 April 2015	07 May 2015
SEHSCT	10 March 2015	21 March 2015	21 April 2015
SHSCT	10 March 2015	14 April 2015	28 April 2015
WHSCT	10 March 2015	18 April 2015	20 April 2015

In addition to this and to allow researchers to access data via the HBS, an HBS research application was completed and submitted on 12 March 2015. Following feedback from the HBS Research Governance Board, additional information was provided by the research team and the application for telehealth was approved on 17 April 2015. Researchers who would be working directly with the data were also required to undertake a half day HBS Safe Researcher Training course. This was completed in advance of the telehealth dataset becoming available in the safe haven.

The CCHSC compiled a Change Control Request (CCR) based on the requirements from the research team. TF3 completed an impact assessment based on this and following agreement, the telehealth dataset was extracted (within a five week work period time frame) and information packs were sent out by Fold on behalf of the research team.

Appendix 3: Data requested from TF3 (HBS dataset)

Variable required for each referral	Rationale	Data Source
1.0 Demographic & Core patient details		
Deceased? (yes or no)	To establish whether the patient is alive and able to be contacted to take part in the study.	General Register Office (GRO): death records.
Gender	To categorise the patient for analyses on any disparities in relation to gender.	Dataset from TF3
'Age' will be derived from the 'Date of Birth' field in the original extract.	To classify the patient into appropriate age bands and enable analysis.	
Health & Care Number (HCN) [Pseudonymised identifier]	To facilitate data linkage and enable analysis on the level of service use (patient interactions with their healthcare service). HCN will be appended to the randomised HCN (HBS to assign key using algorithm), before the HCN variable is removed to produce a pseudonymised dataset. This will produce an identifier for HBS based on HCN.	
Permanent home address and contact details - Postcode [SOA and Small area (or first part of postcode, eg. BT1)].	Super Output Area (SOA) to be derived from postcode by TF3. Only SOA will be included in the pseudonymised dataset. Small area or the first part of the post code will be appended to the dataset instead of the full post code.	
Present address and location (if different from permanent address) – Postcode (as above).	To enable analyses based on geographical area to assist with assessment of inequalities, for instance when comparing urban and rural areas.	
2.0 Referral data		
Referring Trust	To enable analysis of data at Trust level and identify the HSC Trust that referred the patient for Telemonitoring NI.	Dataset from TF3
Date of referral	To enable analysis of referrals in different time periods and to provide one start point for time-to-event analysis.	
Referral ID number	To enable identification of the number of referrals to the service for each patient.	
Reason for referral	The condition(s) they were referred for and the services requested will be required to analyse disease state referrals (e.g. in relation to referring Trust).	
Level of priority given to referral (standard/urgent)	To determine the level of urgency with which a patient was referred to the service.	
3.0 Assessment information		
Long term condition(s) to be monitored	To categorise the patient and enable analyses based on these categories.	
Other relevant conditions	To categorise the patient and enable analyses based on these categories. Support profiling work on outcomes by patients for co-morbidities.	

Disease package	To identify and categorise the condition for which the patient is receiving telehealth and to enable analyses based on such categories.	Dataset from TF3
4.0 Data relating to Telemonitoring NI service		
Date of actual installation/delivery	Identify when the patient started using the service. To support the analysis of patient outcomes and resource usage (including service as one start-point for time-to-event analyses).	Dataset from TF3
Cancellation of installation/type of monitoring that was requested to be installed but for some reason it was not installed	To identify if installation was not possible and why: patients in this group will form a control group for analyses	
Reasons for cancellation or not installed		
Start date for Telemonitoring NI	To determine when the patient started using the service.	
Length of monitoring (as proposed at referral)	To provide information on intensity/type of care that was required.	
4.1 Patient plan (details of monitoring)		
Details of Monitoring	To classify the patient at an individual level over time. This will be used to assess how the service supports living with a chronic condition, self-management and improves care and services.	Dataset from TF3
Type of monitoring required (Telemonitoring NI services provided)	To categorise the types of monitoring services received by the patient.	
Frequency for patient to submit data (for instance: daily / twice weekly / weekly / fortnightly).	To provide information on intensity of care.	
Expected outcome	To provide information on intensity/type of care	
Education Package currently being provided to the patient	To inform on the quality of care	
4.2 Vital signs at baseline and end of monitoring (include those which are relevant to condition(s) patient is being monitored for		
Weight	To provide measures which relate to the condition each patient is being monitored for. This will be used to describe the types of patients who were referred. The measures (taken a baseline and end of monitoring) will be used in an analysis of comparison of the effect of the service.	Dataset from TF3
Temperature		
Pulse		
Oxygen saturation		
Blood pressure		
Blood glucose readings		
4.3 Review and discharge data		
Review date (each date for this referral)	To allow for descriptive analysis in different time periods and analyses of the intervals between referral, installation, reviews and discharge.	Dataset from TF3
Expected outcome (decisions made during each review)	To provide information on intensity/type of care and decisions made during each review.	

Discharge Date	To allow for descriptive analysis in different time periods and analyses of the intervals between referral, installation, reviews and discharge.	Dataset from TF3
Reason for discharge	To provide information on outcomes and to compare groups who were discharged successfully or who were discharged for other reasons.	
Date of reinstallation of patient equipment	To allow for descriptive analysis in different time periods.	
Date of removal of patient equipment	This variable may be used to determine when patients finish using the service and patterns of availability and re-use of equipment.	
5.0 Patient Specific Information		
Ethnic origin	To describe the types of patient who were referred.	Dataset from TF3
Language of choice	To provide information on potential resource issues.	
Communication issues		
Mobility issues		
6.0 Healthcare service use and interactions		
6.1 Hospital admissions (for each episode)		
Admission date	Validation against linkage work.	Available in the HBS (PAS / HIS metadata information)
Reason for admission		
Hospital based procedures		
Procedure code		
Elective or non-elective		
Service code and service description		
Currency code / Healthcare Resource Group (HRG)		
Discharge date	To allow for descriptive analysis in different time periods and for analysis of costs.	
Site discharged to	Validation against linkage work.	
6.2 Accident and Emergency (A&E) data (provide details for each episode)		
Date of attendance at A&E	Validation against linkage work.	Available in the HBS (PAS / HIS metadata information)
Reason for attendance at A&E		
Service code and service description		
Currency code / Healthcare Resource Group (HRG)		
Leading to admission or no admission		
Procedures carried out at A&E		
Next steps after attendance at A&E		
6.3 Hospital outpatient clinic data (provide details for each episode)		
Type of outpatient clinic (service description/specialty)	Validation against linkage work.	Available in the HBS (PAS / HIS metadata information)
Service code and service description		
Currency code / Healthcare Resource Group (HRG)		
Consultant-led or non-consultant-led		
First attendance or follow-up		

Date of attendance at outpatient clinic	Validation against linkage work.	Available in the HBS (PAS / HIS metadata information)
Reason for attendance (diagnosis code)		
Procedures carried out during attendance at outpatient clinic		
7.0 Lifestyle	To profile users of the service. Support profiling work on characteristics of users.	Dataset from TF3
Contact date		
Details about lifestyle		
Smoking status		
Weight		
Diet details		
Fluid intake		
Cognitive skills/ability		
8.0 Prescription and dispensing data (medication details – all)		Available in the HBS Enhanced Prescribing Database
Date entered		
Drug name		
Dosage		
Frequency		
Dosage unit		
9.0 GP Practice details		
GP Practice Code	To allow for aggregation of data into geographies.	Dataset from TF3
10.0 Additional (Clinical Processes)		

Appendix 4: Descriptive study supplementary Tables and Figures

Table 4.1: age statistics (whole telehealth dataset: 3944 people)

		Age
n	Valid	3944
	Missing	0
Mean (years)		57.57
Std. Error of Mean		.316
Median (years)		63.00
Mode (years)		69
Std. Deviation		19.821
Variance		392.872
Minimum		4
Maximum		99
Percentiles	25	41.00
	50	63.00
	75	73.00

Table 4.2: Referrals by Trust (referral level data).

Trust	n	%	Cumulative %
BHSCT	456	10.8	10.8
NHSCT	1228	29.1	39.9
SHSCT	968	23.0	62.9
SEHSCT	730	17.3	80.2
WHSCT	834	19.8	100.0
Total	4216	100.0	

Table 4.3: Referrals on a person level (including persons referred from multiple Trusts).

Referring Trusts	n	%	Cumulative %
BHSCT	429	10.9	10.9
NHSCT	1129	28.6	39.5
SHSCT	924	23.4	62.9
SEHSCT	674	17.1	90.0
WHSCT	776	19.7	99.7
Mixed HSCTs (S&SE, SE&N, W& SE, B&N, B&SE).	12	0.3	100.0
Total	3944	100.0	

Table 4.4: Conditions referred for (referral basis)

Conditions referred for		n	%	Valid %	Cumulative %
Valid	COPD only	1146	27.2	27.2	27.2
	Diabetes only	888	21.1	21.1	48.2
	Weight management only	835	19.8	19.8	68.1
	Stroke only	334	7.9	7.9	76.0
	CHF only	317	7.5	7.5	83.5
	Kidney only	192	4.6	4.6	88.0
	Other only	118	2.8	2.8	90.8
	Diabetes with weight management	108	2.6	2.6	93.4
	CHF with COPD	66	1.6	1.6	95.0
	COPD with other	63	1.5	1.5	96.5
	Gestational diabetes only	44	1.0	1.0	97.5
	Hypertension only	42	1.0	1.0	98.5
	Mixed other*	42	1.0	1.0	99.5
	COPD with diabetes	11	.3	.3	99.8
	CHF with diabetes	10	.2	.2	100.0
	Total	4216	100.0	100.0	

* Mixed/other consists of the following combinations of conditions referred for:

- COPD/Diabetes
- Diabetes with ICD (kidney, gestational diabetes, stroke & other)
- CHF/COPD/diabetes
- CHF/COPD with ICD (other & kidney)
- Hypertension with ICD (stroke)
- CHF with ICD (other & weight management)
- CHF/COPD/diabetes with ICD (other)
- COPD/diabetes with ICD (stroke with other, other & kidney)
- Diabetes/hypertension
- COPD/hypertension
- Stroke/other
- Stroke/kidney
- Stroke/weight management
- CHF/diabetes with ICD (kidney)

Table 4.5: Conditions referred for on a person level.

Conditions referred for	n	%	Valid %	Cumulative %
COPD only	1046	26.5	26.5	26.5
Diabetes only	825	20.9	20.9	47.4
Weight management only	795	20.2	20.2	67.6
Stroke only	321	8.1	8.1	75.7
CHF only	295	7.5	7.5	83.2
Kidney problems only	178	4.5	4.5	87.7
Hypertension only	38	1.0	1.0	88.7
Diabetes with wt mgmt	104	2.6	2.6	91.3
CHF with COPD	54	1.4	1.4	92.7
COPD with other	77	2.0	2.0	94.7
Gestational diabetes only	44	1.1	1.1	95.8
Mixed other	39	1.0	1.0	96.8
Other only	102	2.6	2.6	99.3
Target condition & other	26	.7	.7	100.0
Total	3944	100.0	100.0	

Table: 4.6: Disease packages associated with referrals.

Disease package	n	%	Valid %	Cumulative %
COPD	976	23.1	23.1	23.1
COPD with BP	290	6.9	6.9	30.0
COPD/Heart Failure	97	2.3	2.3	32.3
Diabetes Home Based	1395	33.1	33.1	65.4
Diabetes Mobile	562	13.3	13.3	78.7
Diabetes/Heart Failure	12	.3	.3	79.0
Heart Failure	325	7.7	7.7	86.7
Other (i.e. Heart Failure ECG or Diabetes/COPD)	15	.4	.4	87.1
Stroke	371	8.8	8.8	95.9
Stroke Mobile	78	1.9	1.9	97.7
Stroke/Diabetes	95	2.3	2.3	100.0
Total	4216	100.0	100.0	

Table 4.7: installed referrals over quarters since the telehealth service commenced in December 2011.

Installations Qs	n	%	Valid %	Cumulative %
Not installed	408	9.7	9.7	9.7
Oct - Dec 2011	131	3.1	3.1	12.8
Jan - Mar 2012	426	10.1	10.1	22.9
Apr - Jun 2012	308	7.3	7.3	30.2
Jul - Sept 2012	214	5.1	5.1	35.3
Oct - Dec 2012	258	6.1	6.1	41.4
Jan - Mar 2013	175	4.2	4.2	45.5
Apr - Jun 2013	341	8.1	8.1	53.6
Jul - Sept 2013	302	7.2	7.2	60.8
Oct - Dec 2013	265	6.3	6.3	67.1
Jan - Mar 2014	363	8.6	8.6	75.7
Apr - Jun 2014	235	5.6	5.6	81.3
Jul - Sept 2014	214	5.1	5.1	86.3
Oct - Dec 2014	265	6.3	6.3	92.6
Jan - Mar 2015	201	4.8	4.8	97.4
Apr - May 2015	110	2.6	2.6	100.0
Total	4216	100.0	100.0	

Table 4.8: referrals to telehealth on a quarterly basis (referral basis).

	BHSCT	NHSCT	SHSCT	SEHSCT	WHSCT	Total
Not installed	55	142	83	56	72	408
Oct - Dec 2011	0	34	13	13	71	131
Jan - Mar 2012	*	124	146	55	97	422
Apr - Jun 2012	33*	44	95	59	82	280
Jul - Sept 2012	13	56	57	40	48	214
Oct - Dec 2012	23	37	92	50	56	258
Jan - Mar 2013	13	34	51	42	35	175
Apr - Jun 2013	18	165	53	56	49	341
Jul - Sept 2013	47	77	70	55	53	302
Oct - Dec 2013	41	64	49	49	62	265
Jan - Mar 2014	49	143	65	49	57	363
Apr - Jun 2014	45	62	48	39	41	235
Jul - Sept 2014	20	73	46	24	51	214
Oct - Dec 2014	37	73	42	68	45	265
Jan - Mar 2015	35	72	43	50	*	200
Apr - May 2015	28	28	15	25	15*	96
Total	456	1228	968	730	834	

Table 4.9: Conditions referred for by quarter (note that numbers were too small for hypertension and gestational diabetes to be reported on).

	CHF	COPD	Diabetes	Stroke	Kidney problems	Weight management	Other
Not installed	45	105	89	17	15	144	22
Oct - Dec 2011	28	91	28	*	*	0	*
Jan - Mar 2012	80	236	93	32*	0	0	23
Apr - Jun 2012	28	122	112	32	*	*	22
Jul - Sept 2012	25	69	71	21	13*	0	17*
Oct - Dec 2012	30	102	86	28	*	*	13
Jan - Mar 2013	26	72	46	26	10*	10*	*
Apr - Jun 2013	35	72	45	37	23	122	16*
Jul - Sept 2013	14	97	67	32	28	63	*
Oct - Dec 2013	28	70	74	22	15	70	19*
Jan - Mar 2014	17	68	72	25	17	152	21
Apr - Jun 2014	13	39	53	14	21	82	13
Jul - Sept 2014	18	30	48	14	13	92	*
Oct - Dec 2014	12	64	84	21	13	82	15*
Jan - Mar 2015	11*	48	50	23*	22	72	12
Apr - May 2015	*	18	22	*	11	55	*

Table 4.10: frequency that patients submit data.

Frequency to submit data	n	%	Valid %	Cumulative %
Every day	1092	25.9	25.9	25.9
Other (including weekends)	378	9.0	9.0	34.9
Week days	927	22.0	22.0	56.9
Weekly	1819	43.1	43.1	100.0
Total	4216	100.0	100.0	

Table 4.11: overall patient type categorised on a person level.

Overall patient type	n	%	Valid %	Cumulative %
Never installed	114	2.9	2.9	2.9
Not successful	249	6.3	6.3	9.2
Successful	571	14.5	14.5	23.7
Discharged, reason unknown	289	7.3	7.3	31.0
Ongoing	736	18.7	18.7	49.7
Non-target condition	1549	39.3	39.3	88.9
Mixed or other	436	11.1	11.1	100.0
Total	3944	100.0	100.0	

Table 4.12: overall patient type by Trust categorised on a person level.

Overall patient type	Never installed	Not successful	Successful	Discharged, reason unknown	Ongoing	Non-target condition	Mixed or other	Total
BHSCT & Multi	10	28	27	32	60	253	26	436
NHSCT	29	46	137	56	186	568	109	1131
SHSCT	23	59	100	68	174	368	133	925
SEHSCT	28	63	167	55	162	122	78	675
WHSCT	24	53	140	78	154	238	90	777
Total	114	249	571	289	736	1549	436	3944

Table 4.13: referral numbers relating to LGDs .

Local Government District (LGD)	n	%	Valid %	Cumulative %
Unknown	53	1.3	1.3	1.3
Antrim	169	4.1	4.1	5.3
Ards	208	5.0	5.0	10.3
Armagh	179	4.3	4.3	14.6
Ballymena	216	5.2	5.2	19.8
Ballymoney	102	2.4	2.4	22.2
Banbridge	113	2.7	2.7	24.9
Belfast	306	7.3	7.3	32.3
Carrickfergus	86	2.1	2.1	34.3
Castlereagh	75	1.8	1.8	36.1
Coleraine	171	4.1	4.1	40.2
Cookstown	125	3.0	3.0	43.2
Craigavon	218	5.2	5.2	48.5
Derry	290	7.0	7.0	55.4
Down	112	2.7	2.7	58.1
Dungannon	156	3.7	3.7	61.8
Fermanagh	232	5.6	5.6	67.4
Larne	94	2.3	2.3	69.6
Limavady	69	1.7	1.7	71.3
Lisburn	256	6.1	6.1	77.4
Magherafelt	88	2.1	2.1	79.5
Moyle	55	1.3	1.3	80.9
Newry and Mourne	277	6.6	6.6	87.5
Newtownabbey	141	3.4	3.4	90.9
North Down	172	4.1	4.1	95.0
Omagh	93	2.2	2.2	97.2
Strabane	115	2.8	2.8	100.0
Total	4171	100.0	100.0	

Table 4.14: Geographies (SOA) indicating distribution of services in terms of deprivation (overall MDM rank and proximity to services domain only).

Decile	MDM rank	MDM rank %	Proximity rank	Proximity rank %
Unknown	53	N/A	53	N/A
1	399	9.7	507	12.3
2	516	12.5	481	11.7
3	517	12.6	442	10.7
4	436	10.6	384	9.3
5	464	11.3	390	9.5
6	500	12.1	445	10.8
7	384	9.3	414	10.1
8	415	10.1	403	9.8
9	273	6.6	355	8.6
10	214	5.2	297	7.2
Total	4171	100	4171	100

Table 4.15: Geographies (SOA) indicating distribution of services in terms of urban/rural indicators.

Urban/rural indicator	n	%	Valid %	Cumulative %
Unknown	53	1.3	1.3	1.3
Rural	1531	36.7	36.7	38.0
Urban	2587	62.0	62.0	100.0
Total	4171	100.0	100.0	

Table 4.16: numbers referred more than once by Trust.
Of those with multiple referrals, fewer than ten had been referred by two different Trusts. Combinations of Trusts were as follows: SHSCT & BHSCT, SEHSCT & BHSCT, SEHSCT & NHSCT and BHSCT & NHSCT).

Trust	**Once**	**> once**	**Total**
BHSCT	408	22	431
NHSCT	1043	89	1132
SHSCT	887	38	925
SEHSCT	628	50	678
WHSCT	724	54	778
Total	3690	254	3944

Table 4.17: numbers referred more than once by condition.
Please note that "other" includes other circulatory and respiratory diseases, asthma and blood pressure monitoring. "Kidney problems" refer to those on the service for reasons including having Chronic Kidney Disease, single kidney or having renal failure. "Weight management" captures those on the service for weight management during pregnancy as well as for those who are not pregnant as it was not possible to capture these separately due to the way they had been classified differently by each Trust.

Number of times referred	Once	More than once	Total
COPD only	972	74	1046
Diabetes only	776	49	825
Weight management only	767	28	795
Stroke only	321	*	321
CHF only	282	13	295
Kidney problems only	178	*	178
Hypertension only	38	*	38
Diabetes with weight management	104	*	104
CHF with COPD	37	17	54
COPD with other	62	15	77
Gestational diabetes only	44	0	44
Mixed other	39	*	39
Other only	102	*	102
Target condition & other	*10	*16	26
Total	3691	253	3944

Table 4.18: numbers referred multiple times by age group.

Number of times referred	Once	More than once	Total
0-29	445	22	467
30-39	438	27	465
40-49	321	13	334
50-59	464	29	493
60-69	789	53	842
70-79	824	69	893
80-84	250	30	280
85+	160	10	170
Total	3691	253	3944

Table 4.19: gender by age group

Age group	Female	Male	Total
0-19	61	49	110
20-29	333	24	357
30-39	403	62	465
40-49	203	131	334
50-59	249	244	493
60-69	404	438	842
70-79	416	477	893
80-84	138	142	280
85+	87	83	170
Total	2294	1650	3944

Table 4.20: Age groups of people referred to the telehealth service by Trust.

Age group	BHSCT	NHSCT	SHSCT	SEHSCT	WHSCT	Total
0-19	*	89	*	*	*	89
20-29	86	111	81	43	57	378
30-39	83	130	101	51	100	465
40-49	41	128	59	50	56	334
50-59	51	119	121	101	101	493
60-69	77	176	222	187	180	842
70-79	76	248	218	162	189	893
80+	22	130	123	81	94	450
Total	436	1131	925	675	777	3944

Table 4.21: Condition by Trust

*indicates where numbers exist, please note that numbers given are not true values but are close to true values to enable a non-disclosive output from HBS. NB. Other includes * (kidney problems, mixed other & target condition/other) Other* skews overall total to 3956 (i.e. not true total of 3944 people).

Condition by Trust	BHSCT	NHSCT	SHSCT	SEHSCT	WHSCT	Total
COPD (including with other)	105	240	281	292	205	1123
Diabetes (including with weight management)	70	164	93	304	298	929
CHF (including with other)	*	81	181	33	*	295
Hypertension only	*	26	*	*	*	38
Weight management only	154	368	197	0	76	795
Stroke only	0	84	141	21	75	321
Gestational diabetes only	0	21	0	0	23	44
Other *	103	147	33	27	101	411
Total	432	1131	926	677	778	3956

Table 4.22: Conditions by age group

Conditions referred for	0-19	20-29	30-39	40-49	50-59	60-69	70-79	80-84	85+	Total
COPD (including with other)	0	0	0	21	110	375	438	125	54	1123
Diabetes (including with weight management)	20	88	114	131	184	193	149	35	15	929
CHF only	0	0	0	13	25	57	101	50	49	295
Hypertension only	0	0	0	0	0	23	15	0	0	38
Weight management only	86	239	292	92	45	25	16	0	0	795
Stroke only	0	0	0	32	64	106	73	24	21	321
Kidney problems only	0	10	15	31	37	32	43	10	0	178
Gestational diabetes only	0	14	30	0	0	0	0	0	0	44
Total	106	24	45	97	236	593	670	209	124	3723

Table 4.23: Conditions by gender

Gender	Female	Male	Total
COPD only	558	488	1046
Diabetes only	378	447	825
Weight management only	695	100	795
Stroke only	149	172	321
CHF only	117	178	295
Kidney problems only	81	97	178
Hypertension only	26	12	38
Diabetes with weight management	91	13	104
CHF with COPD	25	29	54
COPD with other	42	35	77
Gestational diabetes only	44	0	44
Mixed other	18	21	39
Other only	58	44	102
Target condition & other	12	14	26
Total	2294	1650	3944

Table 4.24: Age group by gender.

Age group	Female	Male	Total
0-19	61	49	110
20-29	333	24	357
30-39	403	61	464
40-49	203	132	335
50-59	249	244	493
60-69	405	443	848
70-79	416	474	890
80-84	137	141	278
85+	87	82	169
Total	2294	1650	3944

Table 4.25: Age group by patient type.

Patient type	Never installed	Not successful	Successful	Discharged, reason unknown	Ongoing	Non-target condition	Mixed or other	Total
0-39	13	43	39	28	21	769	19	932
40-49	10	24	51	17	39	180	13	334
50-59	19	29	107	45	100	163	30	493
60-69	17	56	158	83	242	190	96	842
70-79	30	62	154	75	230	164	178	893
80-84	13	24	45	27	69	48	54	280
85+	12	11	17	14	35	35	46	170
Total	114	249	571	289	736	1549	436	3944

Appendix 5: Published Health Related Quality of Life and Self-Efficacy Values in other study populations

	EQ-5D index	EQ-VAS Score	Self-Efficacy scale score	GSE
COPD	**0.79** [a]	**70.6** [a]	**3.1** [b]	**26.0** [c]
DM	**0.742** [d]	**61.1** [d]	**7.9** [e]	
HF	**0.31-0.78** [f]	**37-73** [f]	**31** [g]	
HT	**0.9** [h]	**73.4** [h]		

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[b] Garrod R, Marshall J, Jones F. Self efficacy measurement and goal attainment after pulmonary rehabilitation. Int J Chron Obstruct Pulmon Dis. 2008;3(4):791-6.
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[d] Collado Mateo D, García Gordillo MA, Olivares PR, et al. NORMATIVE VALUES OF EQ-5D-5L FOR DIABETES PATIENTS FROM SPAIN. Nutr Hosp. 2015 Oct 1;32(4):1595-602.
[e] Heather Blume, SeAnne Safaii, Samantha Ramsay, et al. The Impact of Diabetes Education Modality and Diabetes Type on Psychosocial Outcomes in Young Adults with Diabetes. Advances in Diabetes and Metabolism 1(1): 21-28, 2013.
[f] Dyer MT, Goldsmith KA, Sharples LS, et al. A review of health utilities using the EQ-5D in studies of cardiovascular disease. Health Qual Life Outcomes. 2010 Jan 28;8:13.
[g] Shuldham C, Theaker C, Jaarsma T , et al. Evaluation of the European Heart Failure Self-care Behaviour Scale in a United Kingdom population. .J Adv Nurs. 2007 Oct;60(1):87-95.
[h] De silva et al.Health related quality of life impact of a triple combination olmesartan, medoxomil, amlodipine besylate and hydrochlrothiazide in subjects with hypertension. Health and Quality of Life Outcomes 2015 13(24).

Appendix 5.1 Telehealth data: descriptive overview of n = 206 questionnaire respondents

This section provides a descriptive overview of the 206 questionnaire respondents to the self-care questionnaire (Section 5.2$_a$). A total of 206 patients consented to take part in the self-care questionnaire study. Of this number, 196 were able to be linked to data held within HBS outlined below.

5.1$_a$ Demographic information

Gender: 114 males and 82 females responded.

Age: respondents ranged from 23 to 87 years of age (mean: 64.34 and a median of 66 years: see Table below).

		Age
N	Valid	196
	Missing	0
Mean (years)		64.34
Std. Error of Mean		.875
Median (years)		66.00
Mode (years)		69
Variance		150.071
Minimum		23
Maximum		87
Percentiles	25	58.00
	50	66.00
	75	73.00

Age group	n	%	Valid %	Cumulative %
20-49	22	11.2	11.2	11.2
50-59	38	19.4	19.4	30.6
60-69	64	32.7	32.7	63.3
70-79	57	29.1	29.1	92.3
80+	15	7.7	7.7	100.0
Total	196	100.0	100.0	

5.1$_{b}$ Referral and service information

5.1$_{b(i)}$ Timeframe:

Date type	Earliest	Latest
Referral	22-Dec-11	15-May-15
Installation	4-Jan-12	22-May-15
Discharge	6-Jun-12	01-Jul-15
Removal	12-Jun-12	08-Jul-15

5.1$_{b(ii)}$ Referring Trusts:

Trust		n	%	Cumulative %
Valid	BHSCT	16	8.2	8.2
	NHSCT	47	24.0	32.1
	SHSCT	43	21.9	54.1
	SEHSCT	58	29.6	83.7
	WHSCT	32	16.3	100.0
	Total	196	100.0	

5.1$_{b(iii)}$ Multiple referrals: Most respondents (181) were referred once only and 15 were referred more than once (maximum of three times).

5.1$_{b(iv)}$ Conditions referred for: All 196 respondents completed the relevant questionnaire for one of four target conditions they were monitored for. This included 87 with COPD, 64 with diabetes, 32 with heart failure and 13 with hypertension.

Predominant health condition	COPD	Diabetes	Hypertension	Heart failure
Belfast Trust	*	*	*	0
Northern Trust	16	17	*	16
South Eastern Trust	33	25	*	*
Southern Trust	26	*	*	16
Western Trust	12	22	*	*
Total	87	64	13	32

*indicates where numbers exist, please note that numbers given are not true values but are close to true values to enable a non-disclosive output from HBS.

5.1$_{b(v)}$ Co-morbidities: Fewer than 10 respondents had co-morbidities with other target conditions. Combinations included CHF with COPD and diabetes with hypertension. Ten had other non-target conditions described, including stroke, asthma, and other circulatory and respiratory diseases.

5.1$_{b(vi)}$ Disease packages: Reflecting conditions referred for, disease packages were as follows (numbers in brackets): COPD (68), COPD with BP (19), Diabetes Home Based (33), Diabetes Mobile (36), Heart Failure (29) and other (including Stroke, COPD/Heart Failure, Heart Failure ECG and Stroke/Diabetes (11).

5.1$_{b(vii)}$ Referral priority: Most respondents had been classified as 'standard' referrals, with only 20 referred as 'urgent.'

5.1$_{b(viii)}$ Type of monitoring required: 121 respondents were referred for the triage service and 76 were referred to the track and trend type of monitoring.

5.1$_{b(ix)}$ Proposed and actual length of monitoring: 109 respondents have no 'actual length of monitoring,' which is not surprising because the sample included those who are still on the service and have not yet been discharged. The 'proposed length of monitoring' is set at the time of referral with the maximum length restricted to 364 days. Many referrals are renewed after this which leads to the longer duration of monitoring in the variable 'actual length of monitoring.' The 'proposed length of monitoring' variable indicated that people had been referred for 14, 42, 91 (mode), 182, 273 and 364 days. Please note that the 'proposed length of monitoring' variable was cleaned to enable reporting.

		Proposed length of monitoring	Actual length of monitoring
N	Valid	196	87
	Missing	0	109
Mean		136.25	310.69
Std. Error of Mean		7.168	31.298
Median		91.00	201.00
Mode		91	0
Variance		10069.563	85223.844
Range		350	1216
Minimum		14	0
Maximum		364	1216
Percentiles	25	91.00	92.00
	50	91.00	201.00
	75	182.00	520.00

5.1$_{b(x)}$ Quarterly uptake of service:

Installation date (quarters)	n	%	Valid %	Cumulative %
Jan - Mar 2012	18	9.2	9.2	11.7
Apr - Jun 2012	20	10.2	10.2	21.9
Jul - Sept 2012	10	5.1	5.1	27.0
Oct - Dec 2012	23	11.7	11.7	38.8
Jan - Mar 2013	13	6.6	6.6	45.4
Apr - Jun 2013	15	7.7	7.7	53.1
Jul - Sept 2013	11	5.6	5.6	58.7
Oct - Dec 2013	12	6.1	6.1	64.8
Jan - Mar 2014	10	5.1	5.1	69.9
Apr - Jun 2014	13	6.6	6.6	76.5
Jul - Sept 2014	10	5.1	5.1	81.6
Oct - Dec 2014	22	11.2	11.2	92.9
Jan - May 2015	14	7.1	7.1	100.0
Total	196	100.0	100.0	

Table XX: quarters installed of 196 sample.

5.1$_{b(xi)}$ Frequency for patient to submit data:

Frequency to submit data	n	%	Valid %	Cumulative %
Every day	62	31.6	31.6	31.6
Other	21	10.7	10.7	42.3
Week days	55	28.1	28.1	70.4
Weekly	58	29.6	29.6	100.0
Total	196	100.0	100.0	

5.1$_{b(xii)}$ Patient types: 110 respondents were from the ongoing group, 17 were discharged with no reason for discharge given, 54 were classified as successful and 15 made up the final group; not successful.

	Never installed	Unsuccessful	Successful	Discharged	Ongoing	Total
BHSCT	0	0	*	*	*	16
NHSCT	*	*	*	*	28	47
SEHSCT	0	*	19	*	30	58
SHSCT	0	0	*	*	26	43
WHSCT	*	*	*	*	*	32
	*	*15	54	17	110	196

*indicates where numbers exist, please note that numbers given are not true values but are close to true values to enable a non-disclosive output from HBS.

5.2 Linked data: healthcare usage and interaction

The following Tables provide a summary of healthcare service use by target condition and patient type.

5.2$_{a(i)}$ Enhanced Prescribing Data (EPD) by condition

EPD		Heart Failure	COPD	Diabetes	Hypertension
N	Valid	32	87	64	13
	Missing	0	0	0	0
Mean		460.31	471.52	432.38	330.54
Std. Error of Mean		41.985	28.545	35.697	116.735
Median		431.50	404.00	363.00	195.00
Mode		211	252	242	21
Std. Deviation		237.503	266.251	285.573	420.895
Variance		56407.835	70889.555	81552.016	177152.269
Range		866	1362	1356	1498
Minimum		87	67	86	21
Maximum		953	1429	1442	1519
Percentiles	25	233.50	269.00	245.75	81.00
	50	431.50	404.00	363.00	195.00
	75	655.50	619.00	529.00	365.50

5.2$_{a(ii)}$ EPD by patient type

EPD		Not successful	Successful	Discharged, no reason	Ongoing
N	Valid	15	54	17	110
	Missing	0	0	0	0
Mean		529.33	392.30	489.76	457.01
Std. Error of Mean		118.270	34.546	62.900	25.213
Median		274.00	342.50	404.00	414.50
Mode		150	199	145	252
Std. Deviation		458.058	253.862	259.342	264.439
Variance		209817.095	64445.760	67258.191	69927.936
Range		1369	1123	1112	1363
Minimum		150	21	145	67
Maximum		1519	1144	1257	1430
Percentiles	25	219.00	206.50	337.00	263.00
	50	274.00	342.50	404.00	414.50
	75	866.00	495.25	623.00	610.00

5.2$_{b(i)}$ Hospital admissions and discharges: elective only by condition

AD: elective		Heart Failure	COPD	Diabetes	Hypertension
N	Valid	32	87	64	13
	Missing	0	0	0	0
Mean		3.88	5.07	3.23	3.23
Std. Error of Mean		.557	2.221	.384	1.007
Median		3.00	2.00	2.00	1.00
Mode		2	0	1	0
Std. Deviation		3.150	20.720	3.069	3.632
Variance		9.919	429.321	9.420	13.192
Range		15	193	12	10
Minimum		0	0	0	0
Maximum		15	193	12	10
Percentiles	25	2.00	.00	1.00	.00
	50	3.00	2.00	2.00	1.00
	75	5.00	4.00	4.00	7.00

5.2$_{b(ii)}$ Hospital admissions and discharges: elective only by patient type

AD: elective		Not successful	Successful	Discharged, no reason	Ongoing
N	Valid	15	54	17	110
	Missing	0	0	0	0
Mean		3.20	3.11	4.53	4.74
Std. Error of Mean		.776	.420	.982	1.759
Median		2.00	2.00	3.00	2.00
Mode		1	0	2	0
Std. Deviation		3.005	3.088	4.048	18.453
Variance		9.029	9.535	16.390	340.508
Range		9	12	15	193
Minimum		0	0	0	0
Maximum		9	12	15	193
Percentiles	25	1.00	1.00	2.00	1.00
	50	2.00	2.00	3.00	2.00
	75	6.00	4.00	7.00	4.00

5.2$_{c(i)}$ Hospital admissions and discharges: non-elective only by condition

AD: non-elective		Heart Failure	COPD	Diabetes	Hypertension
N	Valid	32	87	64	13
	Missing	0	0	0	0
Mean		5.22	7.00	1.31	2.00
Std. Error of Mean		.710	1.047	.212	.784
Median		4.00	4.00	1.00	1.00
Mode		3	1	0	1
Std. Deviation		4.014	9.769	1.699	2.828
Variance		16.112	95.442	2.885	8.000
Range		16	72	7	9
Minimum		0	0	0	0
Maximum		16	72	7	9
Percentiles	25	2.25	2.00	.00	.00
	50	4.00	4.00	1.00	1.00
	75	7.75	8.00	2.00	2.50

5.2$_{c(ii)}$ Hospital admissions and discharges: non-elective only by patient type

AD: non-elective		Not successful	Successful	Discharged, no reason	Ongoing
N	Valid	15	54	17	110
	Missing	0	0	0	0
Mean		3.53	2.96	4.71	5.39
Std. Error of Mean		1.014	.801	1.606	.780
Median		2.00	1.00	2.00	3.00
Mode		0	0	1	1
Std. Deviation		3.925	5.889	6.622	8.179
Variance		15.410	34.678	43.846	66.901
Range		11	40	25	72
Minimum		0	0	0	0
Maximum		11	40	25	72
Percentiles	25	.00	.00	1.00	1.00
	50	2.00	1.00	2.00	3.00
	75	7.00	4.00	5.50	6.00

5.2$_{d(i)}$ Hospital outpatient appointments by condition

Outpatient data		Heart Failure	COPD	Diabetes	Hypertension
N	Valid	32	87	64	13
	Missing	0	0	0	0
Mean		5.22	33.25	50.78	28.31
Std. Error of Mean		.710	3.096	3.677	8.696
Median		4.00	28.00	41.00	16.00
Mode		3	30	36	10
Std. Deviation		4.014	28.878	29.417	31.354
Variance		16.112	833.912	865.348	983.064
Range		16	152	122	106
Minimum		0	1	7	0
Maximum		16	153	129	106
Percentiles	25	27.75	16.00	27.25	9.50
	50	40.00	28.00	41.00	16.00
	75	52.00	40.00	74.00	36.50

5.2$_{d(ii)}$ Hospital outpatient appointments by patient type

Outpatient data		Not successful	Successful	Discharged, no reason	Ongoing
N	Valid	15	54	17	110
	Missing	0	0	0	0
Mean		46.53	42.30	54.47	36.13
Std. Error of Mean		6.388	3.798	7.415	2.877
Median		41.00	34.00	48.00	29.00
Mode		20	27	16	19
Std. Deviation		24.741	27.908	30.572	30.173
Variance		612.124	778.854	934.640	910.406
Range		88	145	97	151
Minimum		17	8	11	0
Maximum		105	153	108	151
Percentiles	25	28.00	26.75	33.50	16.75
	50	41.00	34.00	48.00	29.00
	75	51.00	49.50	77.00	44.00

5.2e(i) A&E episodes by condition

A&E episodes		Heart Failure	COPD	Diabetes	Hypertension
N	Valid	32	87	64	13
	Missing	0	0	0	0
Mean		6.66	10.26	3.02	5.77
Std. Error of Mean		.835	1.409	.426	3.159
Median		5.00	7.00	1.50	3.00
Mode		5	2	1	0[a]
Std. Deviation		4.722	13.146	3.411	11.388
Variance		22.297	172.825	11.635	129.692
Range		20	94	17	43
Minimum		1	1	0	0
Maximum		21	95	17	43
Percentiles	25	4.00	4.00	1.00	.50
	50	5.00	7.00	1.50	3.00
	75	9.00	12.00	5.00	4.50

5.2e(ii) A&E episodes by patient type

A&E episodes		Not successful	Successful	Discharged, no reason	Ongoing
N	Valid	15	54	17	110
	Missing	0	0	0	0
Mean		6.73	6.54	6.76	7.32
Std. Error of Mean		2.730	1.804	1.874	.814
Median		4.00	3.50	3.00	5.00
Mode		1	1	1	2
Std. Deviation		10.573	13.259	7.726	8.539
Variance		111.781	175.800	59.691	72.916
Range		43	95	30	74
Minimum		0	0	0	0
Maximum		43	95	30	74
Percentiles	25	1.00	1.00	1.50	2.00
	50	4.00	3.50	3.00	5.00
	75	8.00	7.00	9.50	9.00

Appendix 6: Descriptive summary of n = 1959 sample (patient types)

6.1 Telehealth data: descriptive overview of n = 1959 sample

This Appendix provides a descriptive overview and serves as an introduction to the 1959 people who are included in sample of patient types for the quantitative effectiveness study and health economic evaluation (Sections 5.2$_b$ and 5.2$_c$).

All persons included in this sample had one of four of the target conditions and were classified as 'never installed, not successful, successful, discharged with no reason given and ongoing. For further details on how patients were categorised see Appendix 1. 293 of these patients were deceased.

6.1$_a$ Demographic information

Gender: the sample is composed of 985 males and 974 females.

Age: patients ranged from 13 to 99 years of age (mean: 64.48 and median of 67 years: see Table below).

		Age
N	Valid	1959
	Missing	0
Mean (years)		64.48
Std. Error of Mean		.338
Median (years)		67.00
Mode (years)		69
Std. Deviation		14.941
Variance		223.248
Minimum		13
Maximum		99
Percentiles	25	57.00
	50	67.00
	75	75.00

Age group	n	%	Valid %	Cumulative %
0-19	17	.9	.9	.9
20-29	50	2.6	2.6	3.4
30-39	76	3.9	3.9	7.3
40-49	142	7.2	7.2	14.5
50-59	301	15.4	15.4	29.9
60-69	558	28.5	28.5	58.4
70-79	549	28.0	28.0	86.4
80-84	177	9.0	9.0	95.5
85+	89	4.5	4.5	100.0
Total	1959	100.0	100.0	

6.1$_b$ Referral and service information

6.1$_{b(i)}$ Timeframe:

Date type	Earliest	Latest	Notes
Referral	09 Dec 2011	29 May 2015	All 1959 have a referral date. 114 referrals were not installed.
Installation	12 Dec 2011	22 May 2015	1845 have been installed. 1109 have an installation and discharge date. 736 installed referrals are still on the service (no discharge date).
Discharge	11 Jan 2012	09 Oct 2015	1109 have a discharge date. 31 of which have been discharged but equipment has not been removed (timeframe: 09 March 2012 to 09 Oct 2015).
Removal	16 Jan 2012	24 Sept 2015	1079 have a removal date. Of the 880 with no removal date: 15 are deceased (timeframe14 Dec 2011 to 2010 Mar 15). This includes those installed, with and without a discharge date and in both cases they have no removal date).

6.1b(ii) Referring Trusts:

Trust		n	%	Cumulative %
Valid	BHSCT	152	7.8	7.8
	NHSCT	455	23.2	31.0
	SHSCT	426	21.7	52.7
	SEHSCT	477	24.3	77.1
	WHSCT	449	22.9	100.0
	Total	1959	100.0	

6.1b(iii) Multiple referrals: Most patients (1794) were referred once only, 154 were referred twice and 11 were referred three times.

6.1b(iv) Conditions referred for: 865 patients were referred with COPD, 755 with diabetes, 233 with heart failure and 39 with hypertension. Additionally 67 had mixed conditions. Mixed conditions contain the following combinations:

- CHF with COPD and diabetes
- CHF with COPD
- CHF with diabetes
- COPD with diabetes
- COPD with hypertension and
- diabetes with hypertension

6.1b(v) Conditions by Trust and co-morbidities (mixed conditions)

Trust	Mixed	CHF	COPD	Diabetes	Hypertension	Total
BHSCT	*	*	*83	69*	*	152
NHSCT	29	67	173	158	28	455
SHSCT	*	138	*207	81*	*	426
SEHSCT	*	27	*258	192*	*	477
WHSCT	25	0	158	266*	*	449
Total	54	232	879	766	28	1959

*indicates where numbers exist, please note that numbers given are not true values but are close to true values to enable a non-disclosive output from HBS.

5.1b(vi) Disease packages:

Disease package	n	%	Valid %	Cumulative %
COPD	667	34.0	34.0	34.0
COPD with BP	199	10.2	10.2	44.2
COPD/Heart Failure	49	2.5	2.5	46.7
Diabetes Home Based, Diabetes/COPD, Diabetes/Heart Failure	323	16.5	16.5	63.2
Diabetes Mobile	457	23.3	23.3	86.5
Heart Failure & Heart Failure ECG	237	12.1	12.1	98.6
Stroke, Stroke Mobile & Stroke/Diabetes	27	1.4	1.4	100.0
Total	1959	100.0	100.0	

6.1b(vii) Referral priority: most patients were classified as 'standard' referrals (1800), with 159 referred as 'urgent.'

6.1b(ix) Type of monitoring required: 1144 patients were referred for the triage service and 815 to the track and trend type of monitoring.

6.1b(x) Proposed and actual length of monitoring: 736 patients have no 'actual length of monitoring', which is due to the sample including those who are still on the service and have not yet been discharged. The 'proposed length of monitoring' is set at the time of referral with the maximum length restricted to 364 days. Many referrals are renewed after this which correlates with the longer duration of monitoring in the variable 'actual length of monitoring.' The 'proposed length of monitoring' variable indicated that people had been referred for 7, 14, 21, 42, 84, 91 (mode), 112, 182, 273 and 364 days.

		Proposed length of monitoring	Actual length of monitoring
N	Valid	1959	1223
	Missing	0	736
Mean		151.41	310.23
Std. Error of Mean		2.435	9.315
Median		91.00	180.00
Mode		91	0
Std. Deviation		107.769	325.765
Variance		11614.075	106122.806
Range		357	1387
Minimum		7	0
Maximum		364	1387
Percentiles	25	91.00	73.00
	50	91.00	180.00
	75	182.00	465.00

6.1b(xi) Frequency for patient to submit data:

Frequency to submit data	Frequency	%	Valid %	Cumulative %
Every day	624	31.9	31.9	31.9
Other (including weekends)	208	10.6	10.6	42.5
Week days	528	27.0	27.0	69.5
Weekly	599	30.6	30.6	100.0
Total	1959	100.0	100.0	

6.1b(xii) Quarterly uptake of service:

Quarters installed	n	%	Valid %	Cumulative %
Not installed	114	5.8	5.8	5.8
Oct - Dec 2011	91	4.6	4.6	10.5
Jan - Mar 2012	262	13.4	13.4	23.8
Apr - Jun 2012	184	9.4	9.4	33.2
Jul - Sept 2012	128	6.5	6.5	39.8
Oct - Dec 2012	152	7.8	7.8	47.5
Jan - Mar 2013	107	5.5	5.5	53.0
Apr - Jun 2013	120	6.1	6.1	59.1
Jul - Sept 2013	136	6.9	6.9	66.1
Oct - Dec 2013	121	6.2	6.2	72.2
Jan - Mar 2014	126	6.4	6.4	78.7
Apr - Jun 2014	93	4.7	4.7	83.4
Jul - Sept 2014	87	4.4	4.4	87.9
Oct - Dec 2014	132	6.7	6.7	94.6
Jan - Mar 2015	77	3.9	3.9	98.5
Apr - May 2015	29	1.5	1.5	100.0
Total	1959	100.0	100.0	

6.1$_{b(xiii)}$ Patient types:

Patient type	n	%	Cumulative %
Never installed	114	5.8	5.8
Not successful	249	12.7	18.5
Successful	571	29.1	47.7
Discharged, reason unknown	289	14.8	62.4
Ongoing	736	37.6	100.0
Total	1959	100.0	

Patient type	Never installed & not successful	Successful	Discharged, reason unknown	Ongoing	Total
BHSCT	33	25	33	61	152
NHSCT	76	137	56	186	455
SHSCT	83	101	68	174	426
SEHSCT	93	168	55	161	477
WHSCT	78	140	77	154	449
Total	363	571	289	736	1959

6.1$_{c(i)}$ Mortality data:

As compared across patient type (never installed versus four other types)

Deceased	n	%	Valid %	Cumulative %
No	3249	82.4	82.4	82.4
Yes	695	17.6	17.6	100
Total	3944	100	100	

	Never installed	Not successful	Successful	Discharged, reason unknown	Ongoing	Non-target condition	Mixed or other	Total
No	76	183	467	212	726	1490	95	3249
Yes	38	66	104	77	10	59	341	695
Total	114	249	571	289	736	1549	436	3944

Mortality comparison	n deceased	Total	% deceased
Total deceased	695	3944	18
1959 sample deceased	295	1959	15
Never installed deceased	38	114	33
4 other patient types deceased	257	1845	14

Installed (deceased)	No	Yes	Total	%
COPD	625	144	769	19
Diabetes	657	35	692	5
Heart failure	167	45	212	21
Hypertension	33*	*	33	0
Target mixed*	109	30	139	22
Total	1590	255	1845	14

Never installed (deceased)	No	Yes	Total	%
COPD	20	18	40	45
Diabetes	37	10	47	21
Heart failure	*	*	16	*
Hypertension	*	*	*	*
Target mixed*	*	*	*	*
Total	76	38	114	33

Mortality comparison	n deceased	Total	% deceased
Total deceased	695	3944	18
1959 sample deceased	295	1959	15
Never installed deceased	38	114	33
Installed deceased	257	1845	14
Never installed deceased COPD	18	40	45
Installed deceased COPD	144	769	19
Never installed deceased diabetes	10	47	21
Installed deceased diabetes	35	692	5
Never installed deceased heart failure	*	16	*
Installed deceased heart failure	45	212	21
Never installed deceased hypertension	*	*	*
Installed deceased hypertension	*	33	0
Never installed deceased target mixed	*	*	*
Installed deceased target mixed	30	139	22

Mortality comparison	n deceased	Total	% deceased
Total	695	3944	18
1959 sample	295	1959	15
Never installed	38	114	33
Installed	257	1845	14
Never installed COPD	18	40	45
Installed COPD	144	769	19
Never installed diabetes	10	47	21
Installed diabetes	35	692	5
Never installed CHF	*	16	33
Installed heart failure	45	212	21
Never installed htn	*	*	33
Installed hypertension	*	33	0
Never installed tgt mixed	*	*	33
Installed target mixed	30	139	22

	Never installed % deceased	Installed % deceased
1959 sample	33	14
COPD	45	19
Diabetes	21	5
Heart failure	33	21
Hypertension	33	0
Target mixed*	33	22

6.2 Linked data: healthcare usage and interaction (n = 1959)

The following Tables provide a summary of healthcare service use by target condition and patient type.

$6.2_{a(i)}$ Enhanced Prescribing Data (EPD) by condition:

EPD		Mixed	CHF	COPD	Diabetes	Hypertension
N	Valid	67	233	865	755	39
	Missing	0	0	0	0	0
Mean		675.04	435.89	519.69	447.79	281.33
Std. Error of Mean		37.176	16.265	9.774	10.206	43.922
Median		614.00	399.00	479.00	396.00	195.00
Mode		478, 608, 709	290	423	358, 362	None (all once only)
Std. Deviation		304.296	248.271	287.474	280.424	274.295
Variance		92595.831	61638.522	82641.329	78637.888	75237.702
Range		1724	1512	3066	1882	1510
Minimum		100	0	0	0	9
Maximum		1824	1512	3066	1882	1519
Percentiles	25	478.00	241.50	315.00	241.00	98.00
	50	614.00	399.00	479.00	396.00	195.00
	75	866.00	578.50	676.00	622.00	435.00

$6.2_{a(ii)}$ EDP by patient type:

EPD		Never installed	Not successful	Successful	Discharged	Ongoing
N	Valid	114	249	571	289	736
	Missing	0	0	0	0	0
Mean		417.94	440.12	440.42	497.39	533.84
Std. Error of Mean		26.014	18.750	10.759	17.496	10.802
Median		361.50	379.00	400.00	455.00	490.00
Mode		118, 175, 181, 216 & 229	286	358	80, 190, 429, 604, 680	0, 219, 397, 423, 425, 549 & 588
Std. Deviation		277.757	295.872	257.091	297.430	293.053
Variance		77149.191	87540.047	66095.830	88464.787	85880.249
Range		1442	1866	1510	1882	3066
Minimum		0	0	0	0	0
Maximum		1442	1866	1510	1882	3066
Percentiles	25	211.50	233.00	247.00	262.50	328.25
	50	361.50	379.00	400.00	455.00	490.00
	75	559.25	573.00	609.00	686.00	689.75

6.2$_{b(i)}$ Hospital admissions and discharges: elective only by condition:

Condition		Mixed	CHF	COPD	Diabetes	Hypertension
N	Valid	67	233	865	755	39
	Missing	0	0	0	0	0
Mean		5.00	2.81	2.59	6.89	2.15
Std. Error of Mean		2.226	.231	.273	1.360	.388
Median		1.00	2.00	1.00	2.00	1.00
Mode		1	1	1	1	1
Std. Deviation		18.223	3.526	8.038	37.370	2.423
Variance		332.091	12.430	64.610	1396.525	5.870
Range		148	36	193	719	10
Minimum		0	0	0	0	0
Maximum		148	36	193	719	10
Sum		335	655	2243	5205	84
Percentiles	25	1.00	1.00	1.00	1.00	.00
	50	1.00	2.00	1.00	2.00	1.00
	75	4.00	4.00	3.00	4.00	3.00

6.2$_{b(ii)}$ Hospital admissions and discharges: elective only by patient type:

Patient type		Never installed	Not successful	Successful	Discharged, no reason	Ongoing
N	Valid	114	249	571	289	736
	Missing	0	0	0	0	0
Mean		2.22	6.72	3.13	7.92	3.42
Std. Error of Mean		.300	2.097	.433	2.970	.352
Median		1.00	1.00	1.00	1.00	2.00
Mode		1	1	1	1	1
Std. Deviation		3.206	33.083	10.358	50.497	9.542
Variance		10.279	1094.500	107.295	2549.953	91.041
Minimum		0	0	0	0	0
Maximum		20	364	191	719	193
Sum		253	1674	1789	2290	2516
Percentiles	25	.00	1.00	1.00	1.00	1.00
	50	1.00	1.00	1.00	1.00	2.00
	75	2.25	4.00	4.00	3.00	4.00

6.2$_{c(i)}$ Hospital admissions and discharges: non-elective only by condition:

Condition		Mixed	CHF	COPD	Diabetes	Hypertension
N	Valid	67	233	865	755	39
	Missing	0	0	0	0	0
Mean		7.28	4.91	6.40	2.73	1.72
Std. Error of Mean		.941	.312	.257	.143	.339
Median		5.00	4.00	4.00	1.00	1.00
Mode		0	0	0	0	0
Std. Deviation		7.706	4.770	7.557	3.935	2.114
Variance		59.388	22.750	57.113	15.485	4.471
Range		26	26	72	41	9
Minimum		0	0	0	0	0
Maximum		26	26	72	41	9
Sum		488	1143	5538	2063	67
Percentiles	25	.00	1.00	1.00	.00	.00
	50	5.00	4.00	4.00	1.00	1.00
	75	13.00	7.00	9.00	4.00	2.00

6.2c(ii) Hospital admissions and discharges: non-elective only by patient type:

Patient type		Never installed	Not successful	Successful	Discharged, no reason	Ongoing
N	Valid	114	249	571	289	736
	Missing	0	0	0	0	0
Mean		5.45	5.11	3.69	4.55	5.41
Std. Error of Mean		.631	.369	.222	.338	.259
Median		3.00	4.00	2.00	2.00	3.00
Mode		0	0	0	0	0
Std. Deviation		6.737	5.829	5.311	5.753	7.036
Variance		45.382	33.976	28.202	33.095	49.508
Range		31	48	41	31	72
Minimum		0	0	0	0	0
Maximum		31	48	41	31	72
Sum		621	1272	2105	1316	3985
Percentiles	25	1.00	1.00	.00	.00	1.00
	50	3.00	4.00	2.00	2.00	3.00
	75	8.00	7.00	5.00	7.00	7.00

6.2d(i) Hospital outpatient appointments by condition

Outpatient data		CHF	COPD	Diabetes	Hypertension	Mixed
N	Valid	190	719	718	41	41
	Missing	0	0	0	0	0
Mean		39.02	35.31	57.07	25.37	64.12
Std. Error of Mean		2.218	1.193	1.722	3.131	7.347
Median		32.00	27.00	44.00	21.00	52.00
Mode		14	15	27	20&21[a]	31
Std. Deviation		30.573	32.002	46.147	20.046	47.046
Variance		934.735	1024.160	2129.512	401.838	2213.360
Range		260	237	358	105	186
Minimum		4	1	1	1	9
Maximum		264	238	359	106	195
Percentiles	25	18.00	15.00	25.00	13.00	29.00
	50	32.00	27.00	44.00	21.00	52.00
	75	50.25	44.00	75.25	34.00	93.00

6.2d(ii) Hospital outpatient appointments by patient type

Outpatient data		Never installed	Not successful	Successful	Discharged	Ongoing
N	Valid	104	229	489	247	638
	Missing	0	0	0	0	0
Mean		41.72	49.66	42.38	47.66	45.73
Std. Error of Mean		3.659	2.920	1.747	2.488	1.606
Median		30.00	37.00	32.00	38.00	33.00
Mode		11 & 19a	22	27	23	24
Std. Deviation		37.318	44.181	38.628	39.106	40.569
Variance		1392.669	1951.999	1492.118	1529.257	1645.866
Range		211	245	358	304	263
Minimum		1	1	1	1	1
Maximum		212	246	359	305	264
Percentiles	25	17.25	20.00	18.00	22.00	19.00
	50	30.00	37.00	32.00	38.00	33.00
	75	54.50	67.50	51.00	63.00	60.25

6.2$_{e(i)}$ A&E episodes by condition

A&E episodes		Mixed	CHF	COPD	Diabetes	Hypertension
N	Valid	44	189	699	606	32
	Missing	0	0	0	0	0
Mean		11.73	7.69	11.18	6.09	5.28
Std. Error of Mean		1.238	.433	.414	.263	1.400
Median		9.00	6.00	8.00	4.00	3.00
Mode		7, 9 & 16[a]	4	4	1	1
Std. Deviation		8.213	5.949	10.948	6.485	7.920
Variance		67.459	35.395	119.864	42.052	62.725
Range		34	33	94	62	42
Minimum		1	1	1	1	1
Maximum		35	34	95	63	43
Percentiles	25	5.25	3.00	4.00	2.00	1.00
	50	9.00	6.00	8.00	4.00	3.00
	75	16.00	10.00	14.00	8.00	5.00

6.2$_{e(ii)}$ A&E episodes by patient type

No A&E episodes		Never installed	Not successful	Successful	Discharged	Ongoing
N	Valid	96	212	429	229	604
	Missing	0	0	0	0	0
Mean		8.24	8.59	7.62	8.96	9.45
Std. Error of Mean		.815	.573	.419	.587	.400
Median		5.00	6.00	5.00	6.00	7.00
Mode		4	4	2	6	4
Std. Deviation		7.985	8.341	8.680	8.889	9.820
Variance		63.763	69.580	75.342	79.012	96.424
Range		35	62	94	52	84
Minimum		1	1	1	1	1
Maximum		36	63	95	53	85
Percentiles	25	3.00	4.00	2.00	3.00	3.00
	50	5.00	6.00	5.00	6.00	7.00
	75	11.00	11.00	10.00	11.50	12.00

Appendix 7: Quantitative supplementary Tables and Figures

Table 7.1: Comparison of difference of average number of non-elective admissions between "Never installed" and "Installed" groups after enrolment with telehealth services.

Average number of admissions (admissions/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	1.3 ± 1.5	1.2 ± 1.1	0.5 ± 0.8	0.2 ± 0.2	0.8 ± 1.0
After (mean ± SD)	0.6 ± 0.9	1.9 ± 3.1	0.8 ± 1.1	0.7 ± 1.5	1.2 ± 2.2
Installed (n)	265	877	731	39	1845
Before (mean ± SD)	0.9 ± 1.0	0.9 ± 1.1	0.4 ± 0.7	0.5 ± 0.9	0.7 ± 1.0
After (mean ± SD)	1.2 ± 1.6	1.6 ± 2.9	0.6 ± 1.1	0.4 ± 0.8	1.1 ± 2.2
Total (n)	285	923	780	43	1959
Before (mean ± SD)	0.9 ± 1.0	0.9 ± 1.1	0.4 ± 0.7	0.4 ± 0.9	0.7 ± 1.0
After (mean ± SD)	1.1 ± 1.6	1.6 ± 2.9	0.6 ± 1.1	0.4 ± 0.9	1.1 ± 2.2
P value	0.01	0.99	0.44	0.46	0.56

Table 7.2: Comparison of difference of average length of stay between "Never installed" and "Installed" groups after enrolment with telehealth services.

Average length of stay (hours/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	304.8 ± 418.8	250.1 ± 298.3	78.6 ± 187.2	17.0 ± 29.4	165.6 ± 260.9
After (mean ± SD)	110.6 ± 195.1	362.8 ± 621.3	114.7 ± 189.6	135.0 ± 270.0	203.8 ± 433.1
Installed (n)	165	877	731	39	1845
Before (mean ± SD)	171.2 ± 263.4	137.6 ± 270.6	60.0 ± 145.8	76.3 ± 252.6	108.6 ± 231.5
After (mean ± SD)	267.5 ± 559.7	266.1 ± 587.6	111.1 ± 333.0	45.3 ± 117.2	200.8 ± 503.6
Total (n)	285	923	780	43	1959
Before (mean ± SD)	180.6 ± 278.2	143.2 ± 273.0	61.2 ± 148.7	70.8 ± 241.0	111.9 ± 233.6
After (mean ± SD)	256.5 ± 543.5	270.9 ± 589.3	111.3 ± 325.8	53.6 ± 135.4	201.0 ± 499.7
P value	0.001	0.87	0.69	0.37	0.22

Table 7.3: Comparison of difference of average number of non-elective admissions between "Never installed" and "Successful and ongoing" groups after enrolment with telehealth services.

Average number of admissions (admissions/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	1.3 ± 1.5	1.2 ± 1.1	0.5 ± 0.8	0.2 ± 0.2	0.8 ± 1.0
After (mean ± SD)	0.6 ± 0.9	1.9 ± 3.1	0.8 ± 1.1	0.7 ± 1.5	1.2 ± 2.2
Successful and ongoing (n)	199	654	470	32	1307
Before (mean ± SD)	1.0 ± 1.0	0.9 ± 1.1	0.4 ± 0.7	0.5 ± 1.0	0.7 ± 1.0
After (mean ± SD)	1.1 ± 1.5	1.5 ± 2.8	0.6 ± 1.1	0.3 ± 0.8	1.1 ± 2.2
Total (n)	219	700	519	36	1421
Before (mean ± SD)	1.0 ± 1.1	0.9 ± 1.1	0.4 ± 0.7	0.4 ± 0.9	0.7 ± 1.0
After (mean ± SD)	1.1 ± 1.5	1.5 ± 2.8	0.6 ± 1.1	0.3 ± 0.9	1.1 ± 2.2
P value	0.26	0.76	0.38	0.40	0.89

Table 7.4: Comparison of difference of average length of stay between "Never installed" and "Successful and ongoing" groups after enrolment with telehealth services.

Average length of stay (hours/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	304.8 ± 418.8	250.1 ± 298.3	78.6 ± 187.2	17.0 ± 29.4	165.6 ± 260.9
After (mean ± SD)	110.6 ± 195.1	362.8 ± 621.3	114.7 ± 189.6	135.0 ± 270.0	203.8 ± 433.1
Successful and ongoing (n)	199	654	470	32	1307
Before (mean ± SD)	178.1 ± 244.4	136.8 ± 291.5	56.9 ± 143.8	88.2 ± 277.9	109.9 ± 243.5
After (mean ± SD)	228.9 ± 473.3	224.4 ± 558.4	99.9 ± 281.0	35.1 ± 118.4	172.4 ± 463.8
Total (n)	219	700	519	36	1421
Before (mean ± SD)	189.6 ± 266.2	144.2 ± 293.1	58.9 ± 148.4	80.3 ± 262.6	114.3 ± 245.3
After (mean ± SD)	218.1 ± 456.0	233.5 ± 563.3	101.3 ± 273.6	46.2 ± 140.3	174.9 ± 461.4
P value	0.004	0.80	0.85	0.32	0.59

Table 7.5: Comparison of difference of average number of non-elective admissions between "Never installed", "Not successful", "Successful", Discharged" and "Ongoing" groups after enrolment with telehealth services.

Average number of admissions (admissions/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	1.3 ± 1.5	1.2 ± 1.1	0.5 ± 0.8	0.2 ± 0.2	0.8 ± 1.0
After (mean ± SD)	0.6 ± 0.9	1.9 ± 3.1	0.8 ± 1.1	0.7 ± 1.5	1.2 ± 2.2
Not successful (n)	30	93	128	4	249
Before (mean ± SD)	0.9 ± 0.9	1.1 ± 1.1	0.5 ± 0.9	0.6 ± 0.7	0.7 ± 1.0
After (mean ± SD)	1.6 ± 1.9	2.3 ± 3.6	0.8 ± 1.4	1.0 ± 0.9	1.5 ± 2.5
Successful (n)	106	188	283	16	571
Before (mean ± SD)	1.0 ± 1.0	0.8 ± 1.1	0.3 ± 0.6	0.2 ± 0.4	0.5 ± 0.8
After (mean ± SD)	1.2 ± 1.7	1.5 ± 2.4	0.6 ± 1.2	0.1 ± 0.2	1.0 ± 1.8
Discharged (n)	36	130	133	3	289
Before (mean ± SD)	0.6 ± 0.8	0.8 ± 1.0	0.4 ± 0.7	0.2 ± 0.3	0.6 ± 0.9
After (mean ± SD)	1.2 ± 1.8	1.9 ± 2.7	0.6 ± 1.0	0.5 ± 0.9	1.3 ± 2.1
Ongoing (n)	93	466	187	16	736
Before (mean ± SD)	0.9 ± 1.0	0.9 ± 1.1	0.5 ± 0.8	0.7 ± 1.3	0.8 ± 1.1
After (mean ± SD)	1.0 ± 1.3	1.4 ± 3.0	0.5 ± 0.9	0.5 ± 1.1	1.1 ± 2.5
Total (n)	285	923	780	43	1959
Before (mean ± SD)	0.9 ± 1.0	0.9 ± 1.1	0.4 ± 0.7	0.4 ± 0.9	0.7 ± 1.0
After (mean ± SD)	1.1 ± 1.6	1.6 ± 2.9	0.6 ± 1.1	0.4 ± 0.9	1.1 ± 2.2
P value	0.009	0.07	0.13	0.37	0.05

Table 7.6: Comparison of difference of average length of stay between "Never installed", "Not successful", "Successful", Discharged" and "Ongoing" groups after enrolment with telehealth services.

Average length of stay (hours/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	304.8 ± 418.8	250.1 ± 298.3	78.6 ± 187.2	17.0 ± 29.4	165.6 ± 260.9
After (mean ± SD)	110.6 ± 195.1	362.8 ± 621.3	114.7 ± 189.6	135.0 ± 270.0	203.8 ± 433.1
Not successful (n)	30	93	128	4	249
Before (mean ± SD)	156.3 ± 200.1	161.0 ± 236.3	78.0 ± 188.6	31.8 ± 37.2	115.9 ± 211.4
After (mean ± SD)	484.0 ± 910.0	487.6 ± 819.8	156.0 ± 353.1	96.9 ± 93.3	319.6 ± 660.4
Successful (n)	106	188	283	16	571
Before (mean ± SD)	191.5 ± 273.4	128.2 ± 385.6	45.8 ± 127.4	23.5 ± 51.1	93.4 ± 266.5
After (mean ± SD)	266.2 ± 541.2	280.9 ± 507.1	110.4 ± 309.7	2.3 ± 5.6	180.5 ± 425.6
Discharged (n)	36	130	133	3	289
Before (mean ± SD)	145.6 ± 388.7	124.9 ± 164.1	53.9 ± 97.6	9.00 ± 15.6	96.4 ± 188.7
After (mean ± SD)	300.3 ± 600.2	316.9 ± 489.8	107.2 ± 458.6	84.4 ± 146.2	226.6 ± 506.1
Ongoing (n)	93	466	187	16	736
Before (mean ± SD)	162.8 ± 206.7	140.2 ± 243.9	73.5 ± 164.6	152.8 ± 384.8	122.7 ± 223.3
After (mean ± SD)	186.4 ± 379.9	201.6 ± 576.8	84.0 ± 230.8	68.0 ± 163.3	166.1 ± 491.6
Total (n)	285	923	780	43	1959
Before (mean ± SD)	180.6 ± 278.2	143.2 ± 273.0	61.2 ± 148.7	70.8 ± 241.0	111.9 ± 233.6
After (mean ± SD)	256.5 ± 543.5	270.9 ± 589.3	111.3 ± 325.8	53.6 ± 135.4	201.0 ± 499.7
P value	0.01	0.001	0.32	0.28	0.001

Table 7.7: Comparison of difference of average emergency visits between "Never installed" and "Installed" groups after enrolment with telehealth services.

Average number of emergency visits (visits/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	1.7 ± 2.0	1.6 ± 1.5	0.9 ± 1.0	0.4 ± 0.3	1.2 ± 1.3
After (mean ± SD)	0.6 ± 0.8	1.9 ± 3.3	0.8 ± 0.9	0.4 ± 0.8	1.2 ± 2.3
Installed (n)	265	877	731	39	1845
Before (mean ± SD)	1.1 ± 1.2	1.4 ± 1.8	0.8 ± 1.2	0.9 ± 1.5	1.1 ± 1.5
After (mean ± SD)	1.3 ± 1.6	2.0 ± 3.2	0.9 ± 1.4	0.8 ± 1.5	1.5 ± 2.5
Total (n)	285	923	780	43	1959
Before (mean ± SD)	1.2 ± 1.3	1.4 ± 1.7	0.8 ± 1.2	0.9 ± 1.4	1.1 ± 1.5
After (mean ± SD)	1.2 ± 1.5	2.0 ± 3.2	0.9 ± 1.4	0.8 ± 1.5	1.5 ± 2.5
P value	0.005	0.49	0.13	0.83	0.04

Table 7.8: Comparison of difference of average number of emergency visits between "Never installed" and "Successful and ongoing" groups after enrolment with telehealth services.

Average number of emergency visits (visits/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	1.7 ± 2.0	1.6 ± 1.5	0.9 ± 1.0	0.4 ± 0.3	1.2 ± 1.3
After (mean ± SD)	0.6 ± 0.8	1.9 ± 3.3	0.8 ± 0.9	0.4 ± 0.8	1.2 ± 2.3
Successful and ongoing (n)	199	654	470	32	1307
Before (mean ± SD)	1.2 ± 1.3	1.4 ± 1.8	0.7 ± 1.2	0.8 ± 1.2	1.1 ± 1.5
After (mean ± SD)	1.2 ± 1.5	1.8 ± 3.0	0.8 ± 1.3	0.7 ± 1.2	1.4 ± 2.4
Total (n)	219	700	519	36	1421
Before (mean ± SD)	1.2 ± 1.4	1.4 ± 1.8	0.7 ± 1.2	0.7 ± 1.1	1.1 ± 1.5
After (mean ± SD)	1.2 ± 1.5	1.8 ± 3.0	0.8 ± 1.3	0.7 ± 1.2	1.4 ± 2.4
P value	0.01	0.70	0.16	0.85	0.10

Table 7.9: Comparison of difference of average number of emergency visits between "Never installed", "Not successful", "Successful", Discharged" and "Ongoing" groups after enrolment with telehealth services.

Average emergency visits (visits/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	1.7 ± 2.0	1.6 ± 1.5	0.9 ± 1.0	0.4 ± 0.3	1.2 ± 1.3
After (mean ± SD)	0.6 ± 0.8	1.9 ± 3.3	0.8 ± 0.9	0.4 ± 0.8	1.2 ± 2.3
Not successful (n)	30	93	128	4	249
Before (mean ± SD)	1.1 ± 1.1	1.4 ± 1.6	1.0 ± 1.5	2.3 ± 3.2	1.2 ± 1.5
After (mean ± SD)	1.6 ± 1.6	2.4 ± 3.7	1.2 ± 1.6	2.0 ± 3.3	1.7 ± 2.7
Successful (n)	106	188	283	16	571
Before (mean ± SD)	1.2 ± 1.3	1.3 ± 1.8	0.6 ± 1.1	0.6 ± 0.6	0.9 ± 1.4
After (mean ± SD)	1.2 ± 1.5	1.9 ± 3.2	0.8 ± 1.4	0.3 ± 0.7	1.2 ± 2.2
Discharged (n)	36	130	133	3	289
Before (mean ± SD)	0.7 ± 0.9	1.4 ± 1.8	0.8 ± 1.0	0.9 ± 0.5	1.1 ± 1.4
After (mean ± SD)	1.4 ± 1.9	2.5 ± 3.4	0.9 ± 1.4	0.8 ± 1.4	1.7 ± 2.6
Ongoing (n)	93	466	187	16	736
Before (mean ± SD)	1.1 ± 1.3	1.4 ± 1.8	0.8 ± 1.3	1.0 ± 1.5	1.2 ± 1.6
After (mean ± SD)	1.3 ± 1.6	1.8 ± 2.9	0.8 ± 1.3	1.1 ± 1.5	1.5 ± 2.5
Total (n)	285	923	780	43	1959
Before (mean ± SD)	1.2 ± 1.3	1.4 ± 1.7	0.8 ± 1.2	0.9 ± 1.4	1.1 ± 1.5
After (mean ± SD)	1.2 ± 1.5	2.0 ± 3.2	0.9 ± 1.4	0.8 ± 1.5	1.5 ± 2.5
P value	0.001	0.08	0.20	0.68	0.01

Table 7.10: Comparison of difference of average number of outpatient visits between "Never installed" and "Installed" groups after enrolment with telehealth services.

Average number of outpatient visits (visits/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	5.6 ± 7.6	6.2 ± 7.6	8.1 ± 8.4	5.2 ± 4.0	6.6 ± 7.7
After (mean ± SD)	4.0 ± 5.2	5.6 ± 11.3	8.1 ± 6.1	5.4 ± 7.0	6.3 ± 8.6
Installed (n)	265	877	731	39	1845
Before (mean ± SD)	5.3 ± 6.6	4.7 ± 5.9	8.4 ± 8.3	3.1 ± 2.4	6.2 ± 7.1
After (mean ± SD)	6.4 ± 6.8	6.0 ± 7.2	10.1 ± 9.7	5.9 ± 6.7	7.6 ± 8.4
Total (n)	285	923	780	43	1959
Before (mean ± SD)	5.4 ± 6.6	4.7 ± 6.0	8.4 ± 8.3	3.3 ± 2.6	6.2 ± 7.1
After (mean ± SD)	6.2 ± 6.7	5.9 ± 7.4	9.9 ± 9.5	5.9 ± 6.6	7.6 ± 8.4
P value	0.23	0.22	0.24	0.22	0.05

Table 7.11: Comparison of difference of average number of outpatient visits between "Never installed" and "Successful and ongoing" groups after enrolment with telehealth services.

Average number of outpatient visits (visits/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	5.6 ± 7.6	6.2 ± 7.6	8.1 ± 8.4	5.2 ± 4.0	6.6 ± 7.7
After (mean ± SD)	4.0 ± 5.2	5.6 ± 11.3	8.1 ± 6.1	5.4 ± 7.0	6.3 ± 8.6
Successful and ongoing (n)	199	654	470	32	1307
Before (mean ± SD)	5.5 ± 6.9	4.6 ± 5.9	8.3 ± 8.3	2.8 ± 2.0	5.9 ± 7.0
After (mean ± SD)	6.8 ± 7.1	5.8 ± 7.0	9.6 ± 9.1	5.3 ± 6.2	7.2 ± 7.9
Total (n)	219	700	519	36	1421
Before (mean ± SD)	5.5 ± 7.0	4.7 ± 6.0	8.3 ± 8.3	3.1 ± 2.4	6.0 ± 7.0
After (mean ± SD)	6.6 ± 6.9	5.8 ± 7.4	9.4 ± 8.9	5.3 ± 6.2	7.1 ± 8.0
P value	0.18	0.24	0.37	0.27	0.07

Table 7.12: Comparison of difference of average number of outpatient visits between "Never installed", "Not successful", "Successful", Discharged" and "Ongoing" groups after enrolment with telehealth services.

Av. outpatient visits (visits/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	5.6 ± 7.6	6.2 ± 7.6	8.1 ± 8.4	5.2 ± 4.0	6.6 ± 7.7
After (mean ± SD)	4.0 ± 5.2	5.6 ± 11.3	8.1 ± 6.1	5.4 ± 7.0	6.3 ± 8.6
Not successful (n)	30	93	128	4	249
Before (mean ± SD)	6.0 ± 6.2	4.6 ± 6.1	9.0 ± 8.2	4.5 ± 2.7	7.0 ± 7.5
After (mean ± SD)	6.7 ± 7.2	6.1 ± 7.4	12.0 ± 11.4	12.0 ± 9.7	9.3 ± 10.1
Successful (n)	106	188	283	16	571
Before (mean ± SD)	5.2 ± 7.3	4.2 ± 5.9	7.0 ± 7.9	2.5 ± 1.9	5.5 ± 6.8
After (mean ± SD)	7.0 ± 6.8	6.3 ± 8.4	8.7 ± 8.9	4.6 ± 4.6	7.3 ± 8.3
Discharged (n)	36	130	133	3	289
Before (mean ± SD)	3.7 ± 4.3	5.3 ± 5.9	8.3 ± 8.2	4.5 ± 4.7	6.6 ± 7.1
After (mean ± SD)	3.4 ± 3.9	6.8 ± 7.7	9.9 ± 9.5	3.9 ± 5.6	7.9 ± 8.5
Ongoing (n)	93	466	187	16	736
Before (mean ± SD)	5.9 ± 6.5	4.7 ± 5.9	10.3 ± 8.7	3.1 ± 2.2	6.2 ± 7.1
After (mean ± SD)	6.7 ± 7.4	5.6 ± 6.3	11.0 ± 9.3	6.0 ± 7.6	7.1 ± 7.7
Total (n)	285	923	780	43	1959
Before (mean ± SD)	5.4 ± 6.6	4.7 ± 6.0	8.4 ± 8.3	3.3 ± 2.6	6.2 ± 7.1
After (mean ± SD)	6.2 ± 6.7	5.9 ± 7.4	9.9 ± 9.5	5.9 ± 6.6	7.5 ± 8.4
P value	0.14	0.05	0.08	0.37	0.001

Table 7.13: Comparison of difference of average number of total cost between "Never installed" and "Installed" groups after enrolment with telehealth services.

Average total cost (£/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	7469.9 ±8871.0	6556.2 ± 6597.0	3332.1 ± 4867.4	1201.4 ± 515.8	4875.6 ± 5919.3
After (mean ± SD)	3134.8 ± 3937.7	9029.5 ± 14509.8	4231.8 ± 5032.2	4160.3 ± 7713.9	5758.2 ± 10155.6
Installed (n)	265	877	731	39	1845
Before (mean ± SD)	4794.6 ± 5869.3	4222.9 ± 5976.8	2878.5 ± 3956.3	2391.8 ± 5208.4	3679.2 ± 5229.1
After (mean ± SD)	6801.9 ± 11122.6	7353.9 ± 13653.4	4188.4 ± 7311.4	2122.6 ± 3325.5	5940.7 ± 11278.4
Total (n)	285	923	780	43	1959
Before (mean ± SD)	4982.4 ± 6144.6	4339.2 ± 6026.8	2907.0 ± 4017.4	2281.0 ± 4968.4	3748.9 ± 5277.5
After (mean ± SD)	6544.6 ± 10812.9	7437.4 ± 13693.9	4191.2 ± 7187.2	2312.1 ± 3822.9	5930.1 ± 11213.1
P value	0.001	0.764	0.654	0.450	0.172

Table 7.14: Comparison of difference of average total cost between "Never installed" and "Successful and ongoing" groups after enrolment with telehealth services.

Average total cost (£/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	7469.9 ±8871.0	6556.2 ± 6597.0	3332.1 ± 4867.4	1201.4 ± 515.8	4875.6 ± 5919.3
After (mean ± SD)	3134.8 ± 3937.7	9029.5 ± 14509.8	4231.8 ± 5032.2	4160.3 ± 7713.9	5758.2 ± 10155.6
Successful and ongoing (n)	199	654	470	32	1307
Before (mean ± SD)	5036.7 ± 5668.4	4177.6 ± 6284.9	2758.4 ± 3877.6	2514.0 ± 5690.9	3662.0 ± 5394.4
After (mean ± SD)	6164.8 ± 9756.7	6447.5 ± 13303.8	3872.8 ± 6415.4	1771.4 ± 3165.3	5304.5 ± 10769.1
Total (n)	219	700	519	36	1421
Before (mean ± SD)	5258.9 ± 6044.4	4333.9 ± 6328.5	2812.5 ± 3979.5	2368.2 ± 5374.3	3759.4 ± 5446.1
After (mean ± SD)	5888.1 ± 9411.5	6617.2 ± 13390.5	3906.7 ± 6294.6	2036.8 ± 3815.0	5340.9 ± 10719.3
P value	0.003	0.927	0.815	0.393	0.455

Table 7.15: Comparison of difference of average total cost between "Never installed", "Not successful", "Successful", Discharged" and "Ongoing" groups after enrolment with telehealth services.

Average total cost (£/year)	HF	COPD	DM	HTN	Total
Never installed (n)	20	46	49	4	114
Before (mean ± SD)	7469.9 ±8871.0	6556.2 ± 6597.0	3332.1 ± 4867.4	1201.4 ± 515.8	4875.6 ± 5919.3
After (mean ± SD)	3134.8 ± 3937.7	9029.5 ± 14509.8	4231.8 ± 5032.2	4160.3 ± 7713.9	5758.2 ± 10155.6
Not successful (n)	30	93	128	4	249
Before (mean ± SD)	4520.7 ± 4348.3	4782.2 ± 5578.5	3436.5 ± 4810.3	2208.4 ± 2606.8	4008.9 ± 5055.2
After (mean ± SD)	10831.2 ± 16982.8	11714.5 ± 17646.2	5514.5± 8190.4	4605.1 ± 3838.2	8507.2 ± 13835.8
Successful (n)	106	188	283	16	571
Before (mean ± SD)	5233.6 ± 6239.9	3926.2 ± 7842.8	2291.7 ± 3410.3	1081.6 ± 1455.7	3176.4 ± 5639.8
After (mean ± SD)	6875.4 ± 11148.3	7497.6 ± 11461.8	3923.3 ± 7056.3	858.4 ± 941.7	5316.9 ± 9383.9
Discharged (n)	36	130	133	3	289
Before (mean ± SD)	3684.8 ± 7793.7	4050.4 ± 4491.0	2765.8 ± 3242.1	1332.2 ± 1116.5	3473.2 ± 4579.6
After (mean ± SD)	6966.0 ± 11806.7	8794.5 ± 11310.2	4027.6 ± 9098.1	2558.4 ± 4259.1	6606.6 ± 10753.5
Ongoing (n)	93	466	187	16	736
Before (mean ± SD)	4812.2 ± 4961.5	4279.1 ± 5540.6	3464.7 ± 4409.8	3946.5 ± 7774.0	4038.8 ± 5168.4
After (mean ± SD)	5355.0 ± 7860.1	6023.8 ± 13967.5	3796.5 ± 5317.7	2684.5 ± 4247.5	5294.9 ± 11739.4
Total (n)	285	923	780	43	1959
Before (mean ± SD)	4982.4 ± 6144.6	4339.2 ± 6026.8	2907.0 ± 4017.4	2281.0 ± 4968.4	3748.9 ± 5277.5
After (mean ± SD)	6544.6 ± 10812.4	7437.4 ± 13693.9	4191.2 ± 7187.2	2312.1 ± 3822.9	5930.1 ± 11213.8
P value	0.007	0.004	0.164	0.363	< 0.001

Health economic evaluation (telehealth service costing)

Table 7.16 Daily disease package charges (£)

Package	Disease package type	£
A	**Diabetes Home Based - Track and Trend 80%**	1.71
A	**Diabetes Home Based 20%**	2.81
B	**Diabetes Mobile - Track and Trend 80%**	1.74
B	**Diabetes Mobile 20%**	2.83
C	**COPD**	2.43
D	**Heart Failure**	2.54
E	**Heart Failure ECG**	2.53
F	**Stroke - Track and Trend 95%**	1.20
F	**Stroke 5%**	2.26
G	**Diabetes/Heart Failure**	2.98
H	**Diabetes/COPD**	2.86
I	**COPD/Heart Failure**	2.64
J	**Stroke /Diabetes - Track and Trend 100%**	1.67
K	**ECG only**	-
Q	**Stroke Mobile**	2.71
Z	**COPD with BP**	2.51

Source: CCHSC 2013/14. Charge per day based on a monitored patient volume of ≤ 48,000 (Band A)
The standing charge is the charge to the CCHSC from TF3 and integrates the labour costs, data centre running costs, programme governance costs, and general programme costs associated with providing the service. The total standing charge for the period December 2011 to January 2016 was £3,673,998 during which time 1,609,281 patient monitored days were recorded. To be able to apportion this standing charge to patients we divided the total cost by the total number of patient monitored days to obtain a daily standing charge rate of £2.28.

Ongoing group (consists of 738 ongoing and 292 non-target conditions).
Assigned discharge date as 09 Oct 2015 (latest discharge date available) to 1030 without discharge date.
Timeframe for 1030 installation dates: 12 Dec 11 - 28 May 15.

Conditions monitored for
Please note that “Other only” refers to non-target conditions (from ICD “other” category).
“Mixed other” refers to mixtures of target conditions which are sometimes referred with non-target conditions, combinations include:

- COPD/Diabetes
- Diabetes with ICD (kidney, gestational diabetes, stroke & other)
- CHF/COPD/diabetes
- CHF/COPD with ICD (other & kidney)
- Hypertension with ICD (stroke)
- CHF with ICD (other & weight management)
- CHF/COPD/diabetes with ICD (other)
- COPD/diabetes with ICD (stroke with other, other & kidney)
- Diabetes/hypertension
- COPD/hypertension

- Stroke/other, Stroke/kidney, Stroke/weight management
- CHF/diabetes with ICD (kidney)

Full period (all 4216 referrals)

Table 7.17 cost statistics

N	Valid	4216
	Missing	0
Mean		£1599.8548
Std. Error of Mean		26.04296
Median		£959.6800
Mode		.00
Std. Deviation		1690.98847
Variance		2859442.000
Range		£7338.14
Minimum		£0.00
Maximum		£7338.14
Sum		£6744987.81
Percentiles	25	£390.0700
	50	£959.6800
	75	£2214.5900

Table 7.18 costs by Trusts

Full period costs/Trust		BHSCT	NHSCT	SEHSCT	SHSCT	WHSCT
N	Valid	456	1228	730	968	834
	Missing	0	0	0	0	0
Mean		1432.8074	1440.3544	1457.8676	1742.3693	1884.9108
Std. Error of Mean		64.41236	47.48252	55.37874	61.19646	60.11862
Median		981.7000	888.1800	885.9000	947.9200	1393.4600
Mode		.00	.00	.00	.00	.00
Std. Deviation		1375.47153	1663.92196	1496.25119	1903.98707	1736.16908
Variance		1891921.918	2768636.298	2238767.614	3625166.766	3014283.084
Range		6305.72	7338.14	6704.47	6746.26	6905.24
Minimum		.00	.00	.00	.00	.00
Maximum		6305.72	7338.14	6704.47	6746.26	6905.24
Sum		653360.18	1768755.20	1064243.37	1686613.47	1572015.59
Percentiles	25	547.5625	285.1675	431.0800	333.0400	506.4025
	50	981.7000	888.1800	885.9000	947.9200	1393.4600
	75	2012.8750	1771.9450	2020.4875	2642.2000	2750.3050

Full period (3186 referrals - excluding ongoing group with no real discharge date)

Table 7.19 cost statistics (excluding ongoing)

N	Valid	3186
	Missing	0
Mean		£1098.5026
Std. Error of Mean		21.59988
Median		£736.3150
Mode		.00
Std. Deviation		1219.19797
Variance		1486443.702
Range		£6675.73
Minimum		£0.00
Maximum		£6675.73
Sum		£3499829.22

Percentiles	25	£257.1100
	50	£736.3150
	75	£1475.3800

Table 7.20 costs by Trusts (excluding ongoing)

Full period costs/Trust		BHSCT	NHSCT	SEHSCT	SHSCT	WHSCT
N	Valid	320	945	541	741	639
	Missing	0	0	0	0	0
Mean		1060.7722	933.6234	980.5491	1075.8330	1487.3845
Std. Error of Mean		59.07247	34.63388	43.41985	45.01933	60.96523
Median		873.9700	582.5800	694.3400	695.4200	883.5400
Mode		.00	.00	.00	.00	.00
Std. Deviation		1056.72049	1064.67513	1009.92004	1225.48542	1541.10641
Variance		1116658.204	1133533.129	1019938.494	1501814.519	2375008.968
Range		5098.99	6404.63	5970.07	6223.96	6675.73
Minimum		.00	.00	.00	.00	.00
Maximum		5098.99	6404.63	5970.07	6223.96	6675.73
Sum		339447.12	882274.12	530477.05	797192.22	950438.71
Percentiles	25	240.5575	184.7500	339.3800	235.4800	355.2700
	50	873.9700	582.5800	694.3400	695.4200	883.5400
	75	1348.3900	1215.1150	1276.4350	1370.6950	2106.8800

Target conditions only (2693 referrals)

Non-target conditions were removed to focus in on the four study conditions, this meant that the following conditions were removed from the sample:

- Weight management only
- Stroke only
- Gestational diabetes only
- Kidney problems only
- Other only

"Target mixed" was generated to include the following:

- Diabetes with weight management
- CHF with COPD
- COPD with other
- Mixed other
- COPD with diabetes
- CHF with other
-

This left 2693 referrals (1523 non-target conditions removed)

Table 7.21 costs by condition (excluding ongoing)

Costs/condition (FT)		Target mixed	Hypertension	Diabetes	COPD	CHF
N	Valid	300	42	888	1146	317
	Missing	0	0	0	0	0
Mean		1748.4348	1135.0960	1438.7364	2586.6096	2045.9358
Std. Error of Mean		109.43796	209.99470	44.86026	60.29160	111.81491
Median		965.7000	382.8050	963.1150	2115.6900	1399.1400
Mode		.00	.00	.00	.00	.00
Std. Deviation		1895.52101	1360.92123	1336.80564	2041.02884	1990.80781
Variance		3592999.895	1852106.590	1787049.314	4165798.723	3963315.722
Range		6905.24	5695.65	5574.11	7338.14	6746.26
Minimum		.00	.00	.00	.00	.00
Maximum		6905.24	5695.65	5574.11	7338.14	6746.26
Sum		524530.45	47674.03	1277597.92	2964254.65	648561.66
Percentiles	25	370.9225	94.4500	447.7600	827.1100	490.5700
	50	965.7000	382.8050	963.1150	2115.6900	1399.1400
	75	2511.5825	1772.8700	2093.0950	4102.6175	3256.5800

Table 7.22 Target conditions only (1918 referrals – excluding ongoing)

Costs/condition (FT)		Target mixed	Hypertension	Diabetes	COPD	CHF
N	Valid	225	30	703	714	246
	Missing	0	0	0	0	0
Mean		1268.2412	498.6877	1119.1289	1725.1481	1369.3773
Std. Error of Mean		98.67799	144.12697	40.98623	59.93882	89.39905
Median		782.1200	187.2150	750.2800	1389.8650	799.0500
Mode		.00	.00	.00	.00	.00
Std. Deviation		1480.16981	789.41592	1086.71499	1601.61187	1402.16934
Variance		2190902.664	623177.495	1180949.476	2565160.580	1966078.868
Range		6675.73	3746.77	5219.08	6483.73	6223.96
Minimum		.00	.00	.00	.00	.00
Maximum		6675.73	3746.77	5219.08	6483.73	6223.96
Sum		285354.27	14960.63	786747.65	1231755.71	336866.82
Percentiles	25	241.2300	88.3600	389.6200	429.2375	342.3550
	50	782.1200	187.2150	750.2800	1389.8650	799.0500
	75	1702.9400	674.6050	1507.1800	2619.1750	1977.5400

Table 7.23 Target conditions only cost per Trust (2693 referrals-including ongoing)

Full period costs/Trust		BHSCT	NHSCT	SEHSCT	SHSCT	WHSCT
N	Valid	186	626	703	590	588
	Missing	0	0	0	0	0
Mean		2335.1814	1983.2231	1491.0701	2390.9578	2258.3162
Std. Error of Mean		120.13012	80.05998	56.45595	86.83253	75.21653
Median		2130.2800	1235.9900	909.8800	1644.5000	1823.5800
Mode		.00	.00	.00	.00	.00
Std. Deviation		1638.35639	2003.10002	1496.88127	2109.15487	1823.90396
Variance		2684211.658	4012409.683	2240653.543	4448534.251	3326625.647
Range		6305.72	7338.14	6704.47	6746.26	6905.24
Minimum		.00	.00	.00	.00	.00
Maximum		6305.72	7338.14	6704.47	6746.26	6905.24
Sum		434343.74	1241497.64	1048222.31	1410665.12	1327889.90
Percentiles	25	850.5700	392.7050	472.8500	583.6300	733.7900
	50	2130.2800	1235.9900	909.8800	1644.5000	1823.5800
	75	3615.1325	3197.0675	2085.3800	4030.8600	3384.3425

Table 7.24 Target conditions only (1918 referrals – excluding ongoing)

Full period costs/Trust		BHSCT	NHSCT	SEHSCT	SHSCT	WHSCT
N	Valid	125	436	515	412	430
	Missing	0	0	0	0	0
Mean		1704.9048	1199.6623	1007.8771	1462.1125	1855.9818
Std. Error of Mean		118.65646	64.61072	44.37584	70.72981	81.66614
Median		1475.0200	694.7650	722.3500	950.1250	1505.2600
Mode		.00	.00	.00	.00	.00
Std. Deviation		1326.61959	1349.11142	1007.04802	1435.65828	1693.46508
Variance		1759919.537	1820101.631	1014145.719	2061114.702	2867823.980
Minimum		.00	.00	.00	.00	.00
Maximum		5098.99	6404.63	5970.07	6223.96	6675.73
Sum		213113.10	523052.77	519056.69	602390.33	798072.19
Percentiles	25	563.2600	232.1275	383.2000	369.7225	479.6125
	50	1475.0200	694.7650	722.3500	950.1250	1505.2600
	75	2590.9150	1801.9900	1304.8900	2121.3175	2737.2475

Health economic evaluation (annual cost basis)

Date of referral no charge
Date of installation £32
Date of discharge £32 (length on service is determined by this minus date of installation)
Date of removal no charge

Table 7.25 Cost break down by year (excluding disease packages)

Year	Referred but not installed	Installations	De-installations	Installation charges (£)	De-installation costs (£)
2011	(1 month) 10	(1month)131	0	4192	0
2012	97	1206	439	38592	14048
2013	125	1083	680	34656	21760
2014	133	1077	1066	34464	34112
2015	(5 months) 43	(5 months) 311	593	9952	18976
	408	3808	2778	121856	88896

The above excludes accounting for discharging 1030 ongoing (see Table below which includes ongoing).

Year	Ongoing	Ongoing de-installed (£)	De-installed total (£)
2011	0	0	0
2012	0	0	14048
2013	0	0	21760
2014	0	0	34112
2015	1030	32960	51936
	1030	32960	121856

Appendix 8: Qualitative research – make-up of studied groups

Table 8.1 Participants in focus group discussions – patients and carers

Trust	Participants		Patient gender		Patient average age (years)
	Patients	Carers	Male	Female	
Belfast	3	1	1	2	72.3
Northern	3	2	1	2	67.6
South Eastern	2	1	1	1	51.0
Southern	3	1	3	0	66.0
Western	4	3	2	2	73.3

Table 8.2 Health professionals interviewed

Trust	Pharmacist		GP		Hospital doctor		Telehealth key worker		Service development manager	
	Male	Female	M	F	M	F	M	F	M	F
Belfast	2	0	2	2	2	0	0	1	0	0
Northern	1	1	2	0	0	0	0	2	0	2
South Eastern	1	1	0	1	1	0	1	1	1	2
Southern	0	2	0	0	0	0	0	2	0	0
Western	2	0	1	0	0	0	0	1	1	1
Total	10		8		3		8		7	