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Research Department

Strategic Research Series – Number 023

Telehealth Research Across the Community – Remote Monitoring of Chronic Obstructive Pulmonary Disease

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Executive Summary

Telehealth, or the use of information and communication technology to deliver health services over distance, is currently revolutionising patient care around the world. In recent years, telehealth has become increasing relevant as the population ages and we consider ways to improve the quality, efficiency and cost effectiveness of the management of people living with chronic illness. Whilst there is a growing body of research on the benefits of telehealth for chronic conditions such as heart failure, diabetes and wounds, there is still rather limited methodologically sound evidence in relation to the benefits and financial viability of telehealth monitoring for people with Chronic Obstructive Pulmonary Disease (COPD).

The aim of this study was to test the hypothesis that self-monitoring via home-based telehealth equipment can, when combined with ongoing remote monitoring of the patient's results by a nurse, reduce the incidence of hospitalisations and Emergency Department visits for people with COPD.

The study design was a randomised controlled trial comparing the outcomes for 40 participants using the telehealth equipment with 40 participants who received information and usual care only. For a period of six months, those in the intervention group measured their own vital signs daily, which included blood pressure, weight, pulse rate and oxygen saturation levels. The results were then transmitted automatically via telephone to a secure web site where they were monitored daily by the telehealth nurse and interventions introduced where required.

The key findings of this trial were:

- The Telehealth intervention resulted in a reduction in health service utilisation for the Telehealth group. Although there was not a statistically significant difference between the groups in terms of mean COPD related ED presentations, hospitalisations or length of stay, the intervention nearly halved the total number of COPD related ED presentations, hospitalisations and days spent in hospital of the Telehealth Group.

- The substantial difference between the groups in their utilisation of health services resulted in considerable cost savings for the telehealth group. It was calculated that for each person in the Telehealth Group, there would be an annual cost saving of $2,931.

- Participants reported a high level of satisfaction with the user friendliness of the equipment and the monitoring service itself. A large percentage agreed that they would be receptive to using such a service in the future.

- Participants in the Telehealth group reported benefits relating to increased self confidence, control and awareness in managing their condition, as well as an improved sense of security and reduced anxiety.

- Daily monitoring was found for some clients to have prompted more communication about their condition with their GP. Participants also reported asking their GP to explain their results and in some cases used their monitoring results to justify/open discussion with their GP about reviewing their medications.

- The telehealth service model required that participants' respiratory consultants were involved in the study to (1) take clinical governance and (2) access the participants' daily readings in the hope that it would assist them to treat their patients' conditions. Consultants had infrequent contact (generally a six month or annual visit) with the participants thus the potential benefits of logging into the website were seldom experienced. It is recommended that in future studies the patient's GP be asked to take clinical governance.

- The benefits found in this research need not be restricted to individuals living in metropolitan areas. Rather, remote monitoring could be extremely beneficial to people living with chronic disease in rural and remote areas where access to health practitioners is limited and often requires significant travel. The equipment used in this research required only a regular telephone line and did not rely on fast speed broadband access which would currently preclude many rural Australians from being able to use this type of technology. Given that the infrastructure to support this type of service is already in place throughout Australia, a telehealth service could as easily be delivered in rural and isolated areas as it is in metropolitan areas.

Prior to this study there was limited evidence as to the economic benefits of telehealth monitoring, particularly in relation to people with COPD. A recent systematic review of the literature available on home telemonitoring for pulmonary conditions, found only two studies which conducted a detailed cost analysis of this approach and only one of these reported actual dollar savings. The findings of this research therefore make an important contribution to building the evidence base regarding the economic viability of such services within the wider health community.

In addition, improvement in participants' self management and control over their condition was evident, which is an important aspect of the telehealth model of care. Assisting individuals to be effective self-managers is a key component of quality care for people living with chronic conditions as it increases the likelihood of early detection of exacerbations, thereby reducing the likelihood of costly hospital admissions. Apart from the obvious health and service utilisation benefits, this research also showed that the telehealth technology was well received by the older people who participated in the trial and they expressed interest in wanting to use such a service in the future if it were available.

This research has shown that remote monitoring of patient vital signs using telehealth equipment can produce significant costs savings for Australia while improving health outcomes for individuals living with COPD. It is an innovative way of improving the efficiency and cost effectiveness in the management of chronic illness and importantly provides a service option that was well received and easily managed by older participants.

Background

Telehealth, or the use of information and communication technology to deliver health services over distance[1], is currently revolutionising patient care around the world. The ways in which telehealth services are delivered and the types of technology used are extremely broad ranging, from simple phone support to wound assessment via video cameras or electronic stethoscopes to enable clinicians to listen to patients' heart and lung function.

Telehealth is becoming increasing relevant as the population ages and we consider ways to improve the quality, efficiency and cost effectiveness of the management of people living with chronic illness. One of the emerging areas in telehealth is the concept of '*Telehomecare*', which is the remote monitoring of patients' vital signs by a nurse using equipment that has been installed in the patient's own home.[2] The patient is trained in the use of the equipment to measure their vital signs which can include: blood pressure, weight, pulse, temperature and oxygen saturation levels. These measurements are transmitted to a central point where any changes from normal readings are reviewed by a nurse and interventions introduced where required to reduce the probability of deterioration leading to exacerbations of their illness.

Telehomecare is fast becoming an innovative solution to the problems faced by many community care agencies as it is seen not only as a way providing prompt medical intervention before deterioration in the patient's condition[3] but also as a way of managing staffing shortages, reducing costs,[4] and increasing patient self-management.[5] Effective self-management is a key component of providing quality care for people living with chronic conditions as it plays an important role in reducing complications and subsequent hospital admissions.[6-7]

One particular chronic condition that requires ongoing self-management to minimise morbidity and has begun to show positive results for patient outcomes using telehealth monitoring is Chronic Obstructive Pulmonary Disease (COPD).[8-9] COPD is a progressive and disabling disease which causes restrictions in lung airflow.[9] People with COPD can often suffer from acute exacerbations which are characterised by severe shortness of breath, coughing fits and sputum production.[8] These exacerbations are not only costly in terms of increased healthcare utilisation and hospitalisations, but they can also significantly reduce the quality of life for the person living with COPD.[10]

COPD presents a significant challenge to the Australian population with current prevalence rates estimated at 18.6% of the population aged 40 years or older.[11] As the population ages the prevalence is set to increase from just under 1.2 million Australians in 2008 to 2.6 million by 2050.[11] The annual cost of COPD is 8.8 billion, with 10% of this total attributed to direct health system expenditure and 77% due to productivity lost due to lower employment, absenteeism and premature death of Australians with COPD.[11] More specifically the financial cost of COPD has been calculated at $7,446 per person each year.[11] In comparison to other health conditions, COPD is more common than some common types of cancer, road traffic accidents, heart disease or diabetes and financially presents a larger cost than cardiovascular disease, osteoporosis, hearing loss or arthritis.[11]

Whilst there is a growing body of research on the benefits of Telehomecare for chronic conditions such as heart failure[12], diabetes[13] and wounds[14], there is still rather limited methodologically sound evidence in relation to the benefits and financial viability of telehealth monitoring for people with COPD.[15] A recent systematic review of the literature available on home telemonitoring for pulmonary conditions found only two studies which conducted a detailed cost analysis of this approach.[15] They concluded that more evaluative research, utilising larger samples sizes and more robust study designs were required in order to confirm the economic viability of this kind of Telehomecare program.[15]

The present study aimed to address this identified gap in current knowledge on the cost effectiveness and associated benefits of telehealth monitoring for people living with COPD.

Aims

The study aimed to test the hypothesis that self-monitoring via home-based telehealth equipment can, when combined with ongoing remote monitoring of the patient's results by a nurse, reduce the incidence of hospitalisations and Emergency Department visits for people with COPD.

The specific objectives of the study were to:

- Implement and evaluate a model of chronic disease self-management using telehealth equipment with remote monitoring.
- Determine if the telehealth intervention resulted in a measurable reduction in hospital admissions and Emergency Department visits and was therefore cost saving.
- Determine whether there were any measurable changes in participants' self-assessed quality of life as a result of the telehealth intervention.
- Determine participants' and GPs'/Respiratory Consultants' satisfaction with the telehealth equipment and monitoring and its perceived effectiveness in increasing individuals' self management of their disease and improving health outcomes.

Methods

Study Design

A randomised controlled trial was used to compare the outcomes for clients receiving the telehealth monitoring (intervention group) with the outcomes for clients receiving usual care (control group) for a period of six months.

Study Population

The study population included all Silver Chain clients who were English speaking, living in the Perth metropolitan area, had a confirmed diagnosis of COPD and who were currently in receipt of oxygen services from Silver Chain. Clients who had a diagnosis of dementia and/or were receiving palliative care services, were excluded from the study. Clients were also excluded if they did not have a telephone landline or were unable to physically use the telehealth equipment due to visual or physical impairment.

Client Recruitment

Clients meeting the selection criteria were identified using Silver Chain's data management system Com-Care, and were then invited by letter to participate in the research. The letter included an information statement and explained that they would be contacted by a research assistant with a few days. If the client was interested, they were visited by a research assistant and informed consent was obtained. The research assistant then informed the consenting clients which group they had been allocated to.

GP/Consultant Recruitment

In order to take part in the study, the participant's General Practitioner or respiratory consultant was required to provide consent and agree to take clinical governance for them while in the study. Once a participant had been recruited to the study, their GP/consultant was sent a fax which included an information statement plus a consent form. The fax explained that their patient had consented to take part and informed them as to which group their patient had been randomly allocated to. If their patient was allocated to the Telehealth group, the fax also included a threshold document in which the GP/consultant was asked to define the normal parameters for their patient in terms of blood pressure, temperature, pulse rate, weight, oxygen flow rate and oxygen saturation levels.

Intervention

Participants allocated to the intervention group were visited at home by the telehealth nurse and provided with equipment required to measure their own vital signs. These included:

- An automatic blood pressure cuff/monitor
- Thermometer
- Scales
- Pulse oximeter
- Docobo hub

The telehealth nurse installed the Docobo hub, trained the participant in the use of all equipment, and showed them how to correctly enter their daily readings into the Docobo hub. Participants were also provided with an instruction manual to use as a reference, and a phone number for the telehealth nurse should they have any difficulties with the equipment or entering their data.

Participants then measured their vital signs (blood pressure, weight, pulse rate, oxygen saturation levels) and answered questions relating to their general state of health and their COPD (eg cough and other symptoms) on a daily basis. The results were transmitted automatically via telephone to a secure web site. Each participant's data was monitored daily by the telehealth nurse using a secure telehealth website and any deviations from the participant's set parameters triggered an alert. The telehealth nurse would then phone the participant to discuss their measurements. The outcome of the phone call and any recommendations were recorded as an intervention on the telehealth website.

During the home visit, the telehealth nurse also provided participants with a calendar to record any hospital admissions, Emergency Department presentations, GP and specialist visits, and an educational book about COPD produced by the Australian Lung Foundation.[16]

Once equipment was installed, the participant's GP/consultant was sent a log-in ID and password so that they could also access the secure telehealth website and view their patient's daily readings should they choose to do so.

Control Group

Clients randomised to the control group were also visited by the telehealth nurse who provided them with the same educational book on COPD and calendar as the intervention group so that they could record hospital admissions, Emergency Department visits, GP and specialist visits.

Data Collection

Data collection was undertaken throughout the six month intervention period and included the following:

- **Hospital admissions, Emergency Department presentations, GP and specialist visits** were recorded in a monthly calendar at the time they occurred for a period of six months. The Research Assistants phoned every client each month to collect this information.
- **Service data** from Silver Chain's information management system ComCare was used to track the number and duration of telehealth nurse visits as well as the time spent monitoring the Telehealth Group.
- **Health Related Quality of Life** (QoL) was measured at baseline and after completion of the trial at six months using the Chronic Respiratory Questionnaire Self Administered Standardized Version (CRQ-SAS).[17]
- **Client satisfaction** Face to face interviews were conducted for all clients in the Telehealth Group after completion of six months on the telehealth trial.
- **GP/Consultant satisfaction** was sought using a one page survey (see Appendix 2) that was faxed to the GP/Consultant after their client had completed their six months on the study.
- **Comparative total costs** The cost evaluation examined the costs to Silver Chain for providing the telehealth option for COPD clients, the net benefits in health system usage for those in the telehealth trial group compared with those in the Information Group, and the annual cost savings to the public health system in Australia based on COPD prevalence and telehealth eligibility.

Ethics

Ethics approval for this project was granted by the Silver Chain Human Research Ethics Committee.

Results

A total of 80 clients were recruited into the study (40 telehealth, 40 information only). To reach 80 participants a total of 171 clients were phoned and asked to participate. Ninety one declined to take part and their reasons for declining are listed below.

Table 1: Reason For Declining Participation

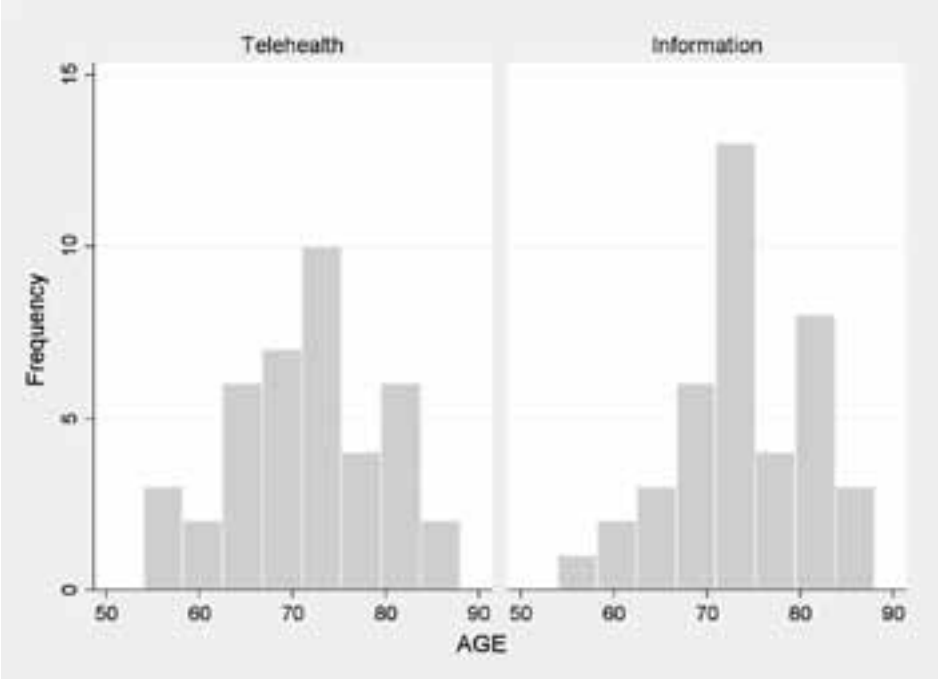
Reason	Number	Percentage
Recently sick/too much going on at the moment	37	40.60%
Not interested	32	35.20%
Felt study would be inconvenient/too time consuming	8	8.80%
Happy with current care from consultant/managing fine	5	5.50%
No landline	4	4.40%
Confused/could not understand what study was about	4	4.40%
Advised by specialist not to participate	1	1.10%
	91	**100.00%**

Nine participants were lost to follow-up (7 deceased, 2 withdrawn) leaving 36 in the Telehealth Group and 35 in the information only group at the completion of the six month study period. Of the two participants who withdrew, one was unable to manage the telehealth equipment so after receiving four support visits the equipment was removed, and the other withdrew because they were no longer interested in taking part in the trial.

Demographics

The mean age for participants in the Telehealth Group was 72, range 54 to 88 years. In the Information Group the mean age was 74 and the range from 57 to 87 years.

Figure 1: Age By Group



The gender balance differed between the two groups in that in the Telehealth Group n=24 (60.0%) were female and n=16 (40.0%) were male while in the Information Group n = 16 (40.0%) were female and n=24 (60%) were male. This difference was not statistically significant.

The majority of participants in both groups lived with family/others, 77.5% for the Telehealth Group and 65.0% in the Information Group. 52.5% of the Telehealth Group and 55.0% of the Information Group had a carer.

Health Related Quality Of Life

The Chronic Respiratory Questionnaire, Self Administered Standardized Activities (CRQ-SAS) version was used in this trial as it was developed specifically to measure the quality of life of people with chronic lung disease. The questions in the CRQ-SAS are divided into four dimensions; dyspnea, fatigue, emotional function and mastery and each of these are reported separately rather than an overall quality of life score. There were no significant differences between the intervention and control groups for any of the domains at baseline or at follow-up at six months. There was however, a statistically significant change found in the mastery domain for the Telehealth Group between baseline and follow-up indicating an increase in mastery over time (4.5 to 5.1; $t(35) = -2.7$; $p = 0.01$). No such change was found in the Information Group over time.

The minimum amount of change that has been found to be clinically significant or important in a respondent's day-to-day life is an improvement of 0.5 per question per dimension17. There are four questions in the domain of mastery and to achieve clinical significance a change of 2 is therefore required. The Telehealth Group improved by 2.3 achieving clinical significance while the Information group changed by only 1.3.

Health System Usage

Over the six month period, health system usage was recorded for each of the 71 participants who were monitored for the entire time. Table 2 shows the number of GP and specialist visits, Emergency Department (ED) presentations, number of hospital admissions and length of stay in hospital for trial participants. These health contacts are shown for COPD health system contacts, non-COPD health system contacts and the combined totals.

As health system usage was based on participant recall and not based on actual health records, assumptions were made about the health system usage in order to be able to code it as COPD related or not. The basis for these assumptions can be found in Appendix 3.

Table 2: Health System Usage

Item	Information Group N Mean (SD)	Telehealth Group N Mean (SD)	Difference	Significance
COPD Related Health System Usage				
GP visits	33 0.94 (1.3)	35 0.97 (1.3)	+2	NS
Specialist visits	55 1.6 (1.7)	60 1.7 (1.7)	+5	NS
ED presentations	11 0.31 (0.63)	6 0.17 (0.51)	-5	NS
Hospital admissions	17 0.49 (0.85)	8 0.22 (0.48)	-9	NS
Hospital LOS (days)	162 4.6 (9.1)	85 2.4 (7.1)	-77	NS

Table 2: Health System Usage (Continued)

Non-COPD Related Health System Usage

GP visits	175 5 (4.3)	216 6 (4.4)	+41	NS
Specialist visits	41 1.2 (1.5)	35 0.97 (1.5)	-6	NS
Emergency Department visits	10 0.29 (0.62)	12 0.33 (0.68)	+2	NS
Hospital visits	9 0.26 (0.89)	8 0.22 (0.59)	-1	NS
Hospital LOS	21 0.6 (2.3)	21 0.58 (1.7)	0	NS

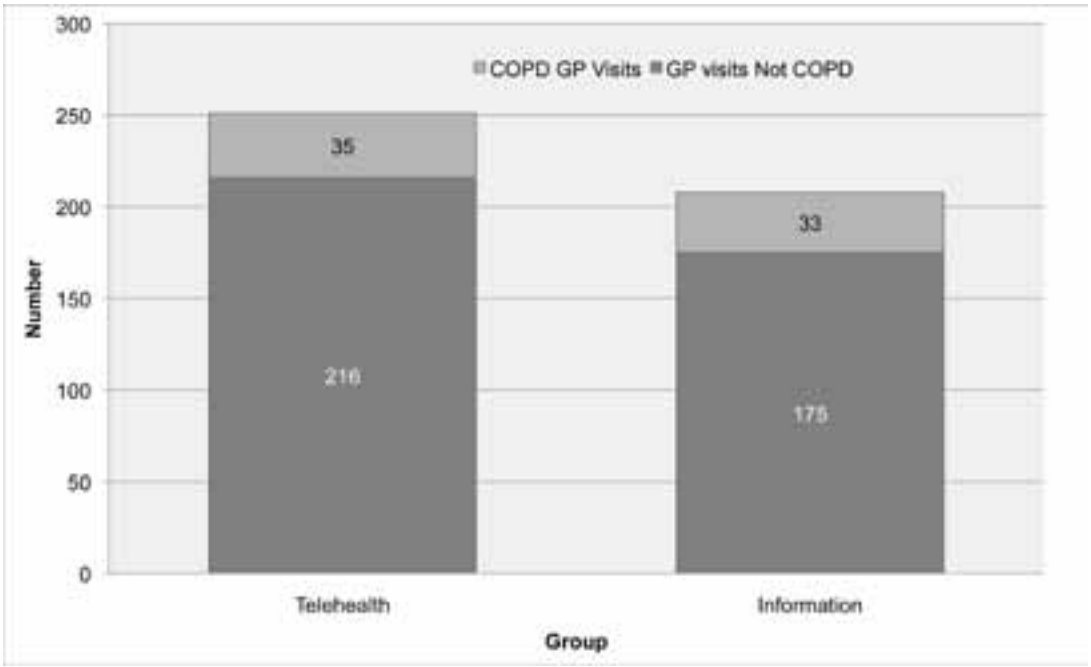
All Related Health System Usage

GP visits	208 5.9 (4.4)	251 7 (5.1)	+43	NS
Specialist visits	96 2.7 (2.1)	95 2.6 (2.2)	-1	NS
Emergency Department visits	21 0.6 (0.95)	18 0.5 (0.77)	-3	NS
Hospital visits	26 0.74 (1.2)	16 0.44 (0.73)	-10	NS
Hospital LOS	183 5.2 (9.3)	106 2.9 (7.3)	-77	NS

GP Visits

Figure 2 shows that participants in the Telehealth Group had more GP visits in total over the six month period than those in the Information Group (251 vs 208). Despite the Telehealth Group attending the GP 43 more times than the Information Group, there was no statistical difference between the average number of times participants in the two groups attended (7 vs 5.9).

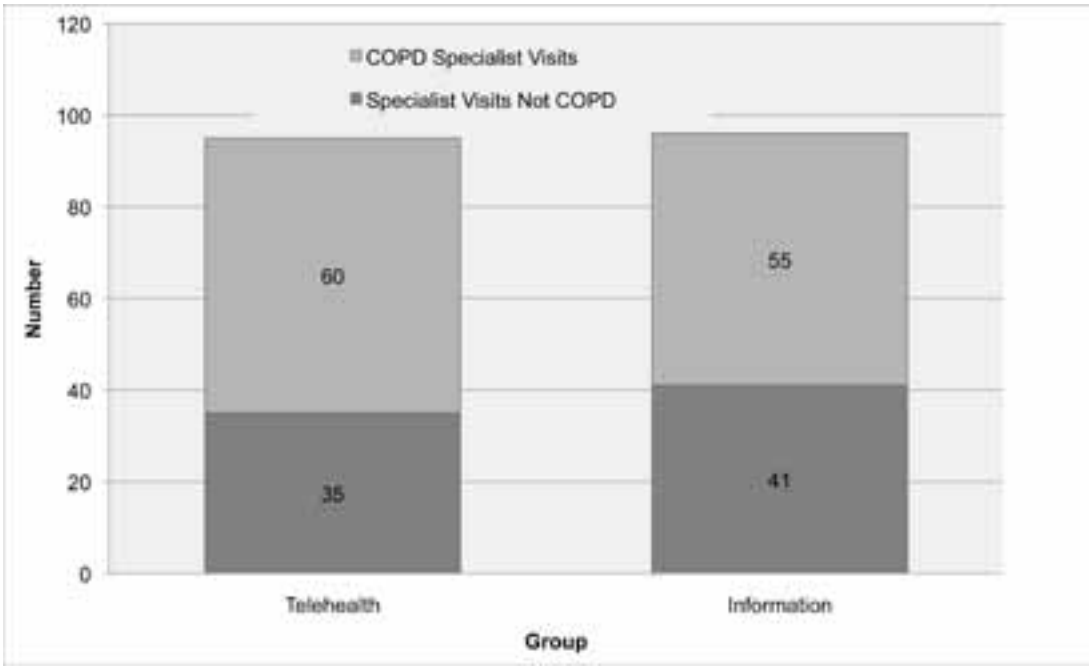
Figure 2: Number of GP Visits



Specialist Visits

Figure 3 shows that participants in both groups had similar numbers of specialist visits both to their respiratory specialist or other specialists. This lack of difference was confirmed by a t test which showed no significant difference between the average number of specialist visits by the two groups.

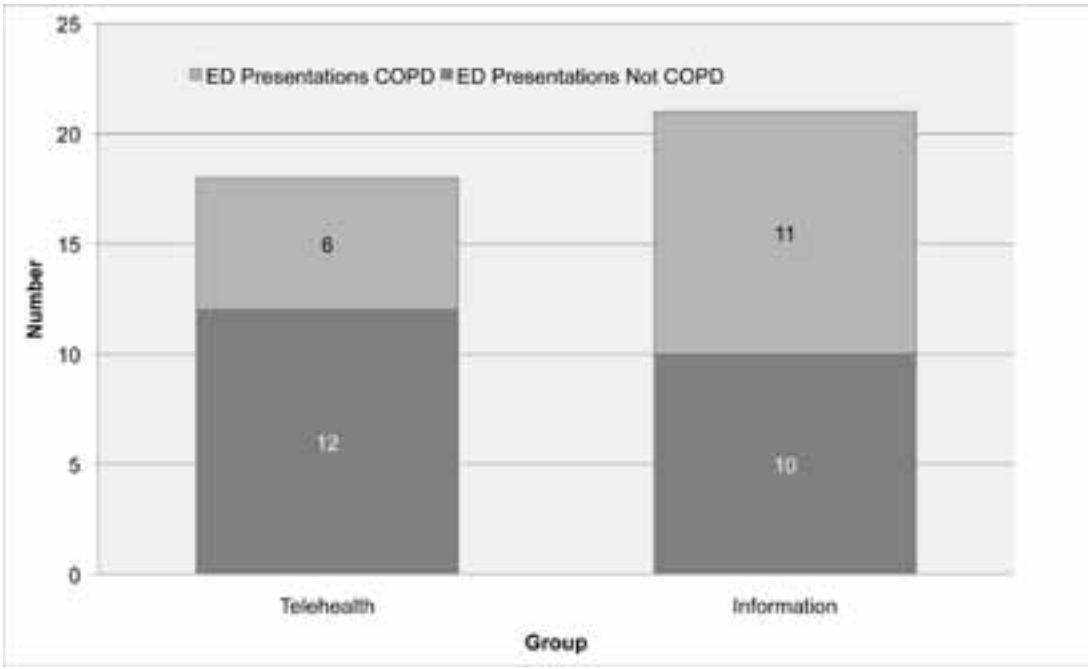
Figure 3: Specialist Visits



Emergency Department (ED) Presentations

As illustrated in Figure 4, the Telehealth Group and the Information Group had similar numbers of ED presentations for non-COPD related reasons (12 vs 10). However when the ED presentations due to COPD were examined, it was found that the Telehealth Group had almost half the number of presentations than the Information Group (6 vs 11) . However, this difference was not statistically significant.

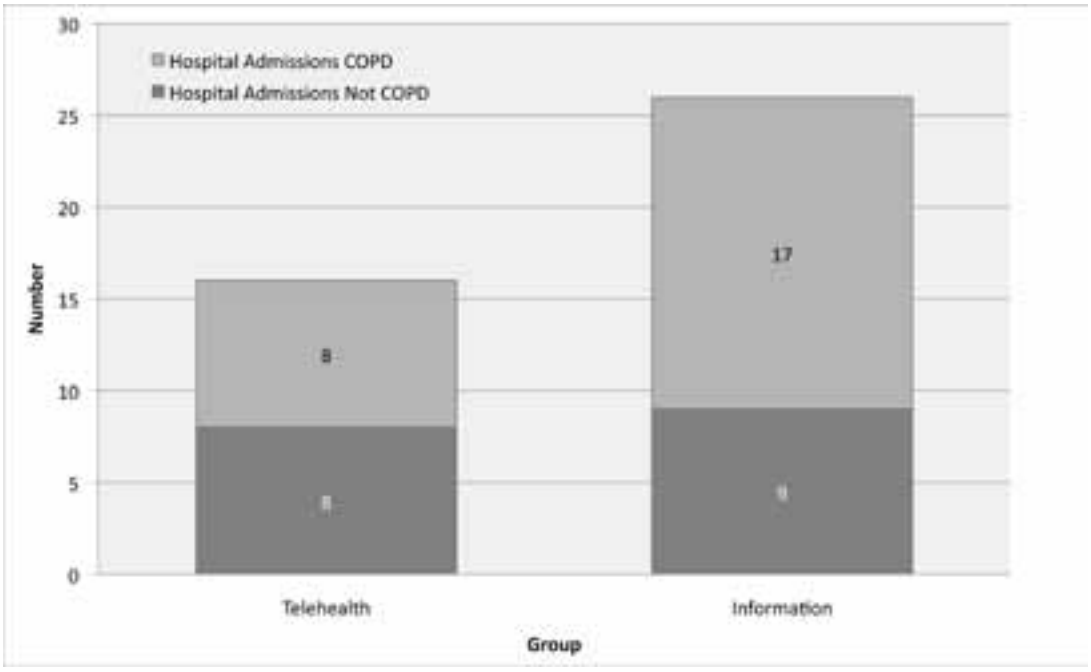
Figure 4: Number of Emergency Department Presentations



Hospital Admissions

As with ED presentations, the number of hospitalisations for non-COPD related reasons was similar for both groups (Telehealth 8 vs Information 9). However, as shown in Figure 5 the number of COPD related hospital admissions for the Telehealth Group was less than half that of the Information Group (8 vs 17). Again this was not statistically significant.

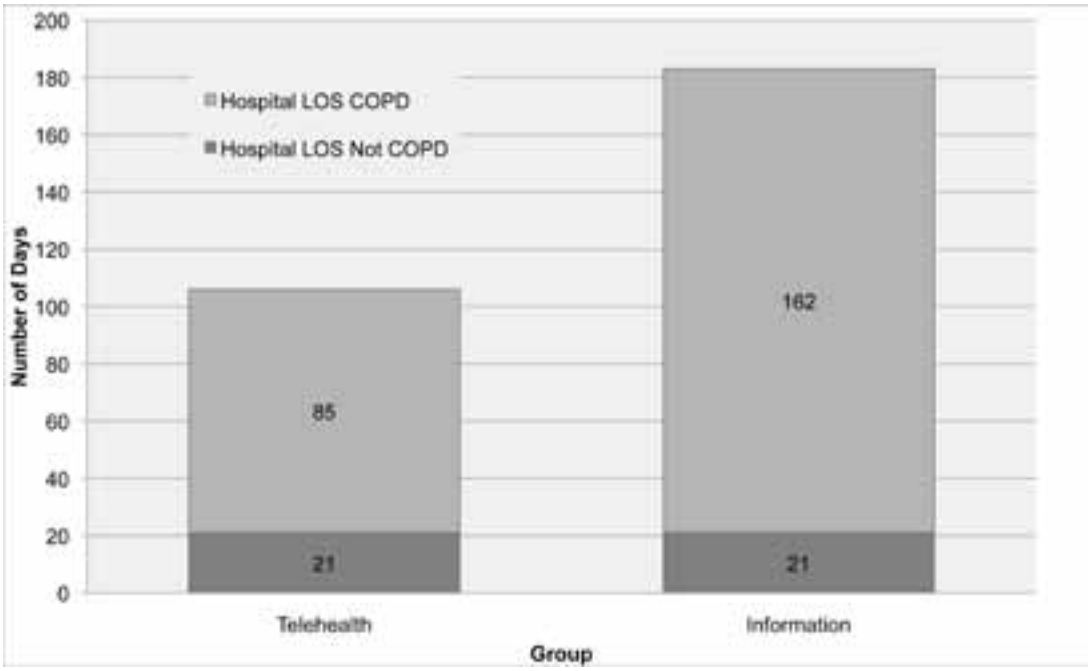
Figure 5: Hospital Admissions



Hospital Length of Stay

Both the Telehealth and Information Groups had the same number of days in hospital over the six month period for non-COPD related admissions (21 days), but when only COPD related admissions are considered, the time spent in hospital over the six month period of the Telehealth Group (85 days) was half that of the Information Group (162 days). This difference was again not statistically significant.

Figure 6: Hospital Length of Stay



Costs

Two types of costs have been included, equipment costs and labour costs. Equipment costs are shown in Table 3. They include the cost of the equipment depreciated over three years using the straight line method plus the weekly cost of monitoring.

Table 3: Annual Equipment Costs

Item	Per Patient Unit Costs	Depreciated Per Patient Unit Costs	Costs
Docobo unit	$1,350	$450.00	$16,200
Pulse oximeter	$220	$73.33	$2,640
BP monitor	$198	$66.00	$2,376
Weight scales	$52	$17.33	$624
Thermometer	$60	$20.00	$720
Subtotal			$22,560
Monitoring system	14 per week	n/a	$26,208
Total			**$48,768**

Table 4 shows the derivation of labour costs over the six months of the trial. The data show minutes of service provided by registered nurses for visits to the home on weekdays, Saturdays and Sundays. However, the data do not differentiate either weeknights or public holidays thereby possibly underestimating the total labour costs. Also included in the labour costs are 18 minutes per week per patient of monitoring patient readings by a registered nurse.

Table 4: Labour costs (6 months) (n = 36)

Registered Nurse	Hourly Rate	Number of Minutes	Number of Hours	Total Costs
Home Visits				
Weekdays	$84	7,483	124.7	$10,475
Saturdays	$108	621	10.4	$1,123
Sundays	$118	52	0.9	$106
Subtotal			8,156	136 $11,704
Monitoring				
18 minutes per week	$84	16,848	280.8	$23,587
Total				**$35,291**

Net Benefits During Trial Six Months

Net benefits were derived by comparing health system usage for those in the Telehealth Group with those in the Information Group. Data on six categories of health system usage were collected: general practitioner (GP) visits, specialist visits, Emergency Department presentations, hospital admissions and days spent in hospital (LOS). To avoid double counting, only GP visits, specialist visits, ED presentations and LOS are included in the calculation of net benefits.

Table 5 applies unit costs to the difference in all health system usage shown in Table 2, column 3. Unit costs for GP, specialist and ED presentations are taken from the 2005/06 unit costs in Table 7.2 of AHURI Homelessness Study18 adjusted by 6.51% per annum increase in ABS health services price index.19 Hospital visits costs are based on length of stay rather than number of hospitalisations. The length of stay cost was calculated using the average cost per bed-day in public hospitals from the WA Health Department annual report for 2006/0720 adjusted by 6.51% per annum increase in ABS health services price index.[19]

Table5: Net Benefits of Telehealth for All Health Conditions (6 Months)

Item	Unit Costs	Difference (Telehealth Minus Information)	Total Cost Savings
GP visits	$48	+43	-$2,064
Specialist visits	$72	-1	$72
ED visits	$465	-3	$1,395
Hospital LOS	$1,468	-77	$113,036
All			**$112,439**
Per Telehealth person in trial (n = 36)			**$3,123**

Table 6 summarises the information for health system usage related only to the COPD health condition.

Table 6: Net Benefits of Telehealth for COPD Related Health System Usage (Six Months)

Item	Unit Costs	Difference (Telehealth Minus Information)	Total Cost Savings
GP visits	$48	+2	-$96
Specialist visits	$72	+5	-$360
ED visits	$465	-5	$2,325
Hospital LOS	$1,468	-77	$113,036
All			**$114,905**

Annual Cost Savings

The equipment and labour costs for the Telehealth Group (n = 36) over a full year amount to $119,350. The annual cost savings, when health system usage cost savings of $224,878 are accounted for, are $105,528 for this group over a full year or $2,931 annually per person. These figures are shown in Table 77.

Table 7: Summary of Annual Cost Savings of COPD Telehealth (n = 36)

Items	Costs/Cost Savings
Equipment costs	$48,768
Labour costs	$70,582
Total costs	**$119,350**
Health system usage cost savings	$224,878
Annual cost savings	$105,528
Per person cost savings	**$2,931**

Participant Satisfaction Interviews

Participant satisfaction interviews were conducted face to face in the participant's own home. Overall, participants were very satisfied with most aspects of the telehealth service. Their responses, as they relate to using the equipment to take their measurements and the benefits they perceived of using the service, are described below.

Using the Telehealth Equipment

The vast majority of participants found most of the equipment (scales, oximeter, thermometer) simple and easy to use without assistance. The exception was the blood pressure machine, with several of the participants commenting that it was problematic and that it would often return an 'ERR' or error reading on the screen.

This was mainly due to some participants being physically unable to get the blood pressure cuff tight enough to record an accurate reading or because the machine was starting to run low on batteries and they did not realise the batteries needed to be changed.

Entering the daily measurements into the Docobo hub took on average between 5 to 10 minutes. Participants reported that the process to input their answers was very user friendly and they experienced no difficulty with reading the questions on the Docobo screen. For those who made a few errors immediately after installation, they felt that they had overcome this after a week of getting used to the technology.

"A little at first, I did a few things wrong, but then I got use to it and it was very quick."

Impact on Hospital Admissions and Emergency Department Visits

Approximately half of the participants felt that having the telehealth service had made an impact on the number of times they had been admitted to hospital or had to visit an Emergency Department. Participants commented that in the past they may have gone to hospital because they were worried or anxious about breathing difficulties but being able to take their own measurements helped to reassure them that everything was stable and there was no need to rush off to hospital.

"There is no doubt that it has probably saved a couple of trips to hospital or it has made me go to the doctor where previously I would have hung on and hung on and ended up going to hospital by ambulance."

"It definitely makes me worry less about things that are happening to me, with the huffing and puffing I don't worry as much anymore...in the past I would have gone off to hospital if worried."

"I used to say to my kids 'oh I would hate for something to happen and you'd rush me to hospital for them to just tell you oh she just needs more oxygen', I'd feel like a real idiot...But with this (oximeter) it was good because I knew if my oxygen levels were alright."

"I used to go into hospital every couple of months but not since being on the telehealth service."

Participants also described the telehealth service as beneficial because it helped them to identify if they were getting sick earlier, which ultimately impacted on them seeking treatment before their conditioned deteriorated and required hospitalisation. It also assisted participants in recognising these symptoms of deterioration and hence when they should commence on their antibiotics if they already had a prescription from their GP.

"The evidence is there if you started to get worse...so yeah it would make you aware if you were getting worse for some reason."

"I know if my blood pressure was up the day before or if it is low they will ring me...so then I'd go to the doctors and if there was a problem, he would find it before it blew into something huge."

"When I did get an infection your crowd were onto it straight away the following morning which was terrific."

"I always have my antibiotics and steroids here but until I was on that I didn't know when to take them."

Those who felt that the service had not made an impact in terms of hospitalisations and ED visits mainly felt this was due to the fact that their condition was relatively stable and that they had not been hospitalised for their COPD in a very long time. Others commented that they had been living with their condition for several years so had already learnt themselves to identify when they were getting sick or may be experiencing an acute exacerbation.

"Well actually I have been reasonably healthy and there has been nothing that I would have gone into hospital for."

"Well I'm fairly well grounded because I've been sick so long that I seem to know when I need extra medication or I am getting sick sort of thing."

Although this group of participants felt that it had not made a significant impact for themselves in terms of reducing hospitalisations, they commented that they thought this type of service would be extremely beneficial for people who had been newly diagnosed with COPD.

"I can see it being absolutely marvellous for people who are just starting to be crook because they don't know what the heck is going on, they don't know what the body can handle so it is all a bit scary…and what I've found over the years is that panic is a hard thing to control. It happens, you know it's happening and try as you might you can't stop it, and if you can't control the panic well you'll end up in hospital whether you want to or not."

Other Major Benefits

Reassurance

Participants generally agreed that the service provided reassurance and peace of mind that a nurse was monitoring their results daily. They also reported that having the equipment enabled them to take their measurements if they were feeling sick or worried and if they could see that their results were within the normal range it reduced their anxiety and showed them there was no need to panic.

"I feel it's great that you have got the assistance there, it gives me a feeling that there is nothing that can't be handled by a phone call so there is no need to panic."

"Your nurse, things have only got to go a little bit queer and she is ringing up which is great."

"It gives you peace of mind more than anything and the fact that if they find anything untoward they give you a ring whereas it would go unnoticed otherwise."

"It stops you worrying...instead of wondering what was wrong and if you are alright you've got the evidence there."

"It gives you an idea of how you are going with your oxygen and things like that...you might think that you're not getting enough oxygen but you can take it and find out that it is ok so it stops you from worrying."

Increased Self-management

Another major benefit was that the daily monitoring helped participants to increase their awareness and self-management of their condition. Participants described having more control over their condition and being more confident in self-managing their condition as they were now more conscious of what their body was doing.

"The main benefit is making you aware of what is going on, because if you are aware of things you can take counter measures can't you."

"The fear of breathing and panic is less now because I am understanding more about my condition and I feel more confident."

"I feel I have much more control over my condition now."

"It made me more aware of what I should keep track of."

"You are conscious of what your body is doing and how you are treating your body."

"It forces you to take a bit more notice of how you are actually going...It is more a subconscious push."

Use of Oxygen

For several participants, using the oximeter on a daily basis resulted in them changing their behaviour in terms of how often they used their oxygen. Some participants found they were using their oxygen almost all day because they were worried about not getting enough oxygen but since having the oximeter, they would use their oxygen only when their levels were low. This also worked in reverse for some participants who realised they needed to be using their oxygen more. Being able to measure oxygen levels directly after performing certain activities also encouraged a change in participants' behaviour as they would stop what they were doing and rest until their oxygen levels returned to normal.

"It just saves sitting on the machine 24/7...At times I have felt funny and then I have checked my oxygen and it has been fine so I have thought oh well I don't need to go on it."

"Before I was on this I was using oxygen all the time and I was actually overdoing the oxygen…Now I just put it on when I'm sort of getting low."

"I feel I am a lot better with my breathing because I am not on my oxygen as much...I think before

I sort of thought I had to be on it but by measuring my oxygen levels I could see that I didn't really need it."

"Sometimes you think oh I won't have the oxygen on I'll just leave it but then you do your measurements and realise you have to."

"The biggest benefit I found because of my condition was the oximeter. I found that because my oxygen drops away so quickly, if I was doing something, I'd grab this thing and think oh I'm down to 84, I better sit for awhile, that kind of thing."

"I suppose I don't get too uptight if little things happen like breathlessness and that, I now sit down and don't try and keep going."

Interaction with GPs

Some participants recorded their readings on a separate notepad that they used to take along to their visits with their GP. This prompted more communication with their GP about their condition as participants asked their GP to explain their results. In two cases, participants used their monitoring results to justify/open discussion with their GP about reviewing their medications.

"I mean sometimes they may ask well how do you feel today and I can say well I feel good today but I felt off yesterday, and they ask you what sort of off and you think well how can I describe it but with this he can see that my blood pressure might have been up."

"I'm going back to the Dr next week to talk about new BP medication which has come from doing all of this so it has been good."

"I took it to my doctor and showed him and he was impressed...if there are any trends developing you can see it."

"I mainly go to the doctor just to get prescriptions, but with this, keeping a record of it, you can see any little thing developing and you can talk to him about it and it is good in that way."

Future Use of Telehealth

Participants were asked if the telehealth equipment and monitoring was provided for free and they were only required to pay for the telephone call costs, would they want to continue using this type of service in the future. The majority of participants (n=28, 78%) agreed that they would want to continue with the service. The reason provided most frequently by those individuals not wanting to continue was that they believed their condition was stable and they did not think ongoing monitoring was necessary.

"Most likely not because I know where I am at with my condition, if I wasn't and I was getting worse type of thing, I most likely would."

"Just because I have to remember every night...I'm not one of those people who are very sick."

Improvements

Although participants were generally very satisfied with the telehealth service as a whole, several suggested that it would be more convenient if the cut off time for entering data was extended to later in the evening. It is currently set at 8pm and some participants found this a problem if they were out with family and had to rush home to enter their data if they had forgotten to do it earlier in the day.

"The only thing I would have appreciated was to make the cut off time at 10pm at night."

Consultant Feedback

Only 5 out of 20 consultants/GPs involved in the study returned the feedback survey. Their feedback presented a mixed picture with half believing that the telehealth service had provided benefits for their patients and agreeing that it would be a service they would recommend for their patients in the future.

"It allowed early detection of change."

Others felt that they did not have the time and didn't really understand what additional benefit it had to offer.

"Did not expect it would help." (reason for not logging into website)

"Need better communication between the people running telehealth and me."

DISCUSSION

The results of this research demonstrate that self-monitoring via home-based telehealth equipment can, when combined with ongoing remote monitoring of the patient's results by a nurse, provide measureable health benefits for people living with COPD. These benefits were found to include reduced Emergency Department presentations, hospital admissions and length of stay in hospital.

Much of the research investigating the use of telehealth technology on hospitalisations has reported good outcomes in terms of reduced hospitalisations and ED presentations. However, a recent systematic review15 found that there was no consistent or definitive evidence in relation to how much this type of technology reduces health service utilisation. The results of this research show that although there was not a statistically significant difference between the Telehealth Group and the control group in terms of mean COPD related ED presentations, hospitalisation or LOS, the intervention nearly halved the total number of COPD related ED presentations, hospitalisations and days spent in hospital of the Telehealth Group. Confirmation that this reduction in service utilisation resulted from the intervention is provided by the fact that no differences between groups were found in terms of the numbers of non-COPD related admissions ED presentations, and days spent in hospital.

The substantial difference between the telehealth and Information Groups in their utilisation of health services resulted in considerable cost savings for the intervention group. It was calculated that for each person in the Telehealth Group, there would be a cost saving of $2,931. Thus for the current population in Australia, 21,874,920,21 in which it has been estimated that there are 15,942 people with severe COPD and using long term oxygen therapy to manage their condition, there would be a saving $46.7 million per annum if there was 100% take-up of the telehealth intervention. At 50% take-up, this saving is $23 million per annum.

Prior to this study there was limited evidence as to the economic benefits of telehealth monitoring, particularly in relation to people with COPD5. A recent systematic review of the literature available on home telemonitoring for pulmonary conditions15, found only two studies which conducted a detailed cost analysis of this approach and only one of these reported actual dollar savings. This study by Pare5, showed a $355 saving per person in the intervention group over six months. These results are consistent with the current study finding that there are significant savings for those receiving a telehealth intervention. The findings of this research therefore make an important contribution to building the evidence base regarding the economic viability of such services within the wider health community.

The current research has also shown that telehealth monitoring can provide users of the service with more than just reduced health service contacts. Participants in this trial reported benefits relating to increased self confidence, control and awareness in managing their condition, as well as an improved sense of security and reduced anxiety. Participants' self-reports of improvement in self-management were supported by the increase in sense of mastery of their disease as found by the CRQ-SAS quality of life tool over time. These results are similar to previous studies which also found that telemonitoring enhanced confidence in self-management22 and improved individuals' sense of security.23

If telehealth is to become a widely adopted service in the future it is also important to understand how older adults feel about using this type of technology. Participants in this study reported a high level of satisfaction with the user friendliness of the equipment and the monitoring service itself. A large percentage (78%) reported that they would be receptive to using such a service in the future. Similar results were found in previous work exploring the acceptability of telehealth technology for older adults.22

Daily monitoring was found for some clients to have prompted more communication about their condition with their GP. Participants also reported asking their GP to explain their results and in some cases used their monitoring results to justify/open discussion with their GP about reviewing their medications. The telehealth service model required that participants' respiratory consultants were involved in the study to (1) take clinical governance and (2) access the participants' daily readings in the hope that it would assist them to treat their patients' conditions. The latter was not however, as successful as hoped. Consultants had infrequent contact (generally a six month or annual visit) with the participants thus the potential benefits of logging into the website were seldom experienced. It is recommended that in future studies the patient's GP is asked to take clinical governance. This would also appear to be the preference of participants as several asked for their GP to be given a log-in.

LIMITATIONS

This research had a number of limitations that need to be considered when conducting future research in this area. Information about participants' pre-trial COPD related hospitalisations was not collected so the research was unable to establish health improvements in individual participants which may have been a result of the telehealth monitoring. In addition, this research relied on retrospective self-report of health system contacts throughout the data collection period and despite the use of calendars to record these the process relied on participant recall which may not have been completely accurate. Both of these limitations could be addressed in future research by using data linkage.

A further limitation was the timing of the study. The research was, because of funding constraints conducted over the summer period when participants with COPD are least likely to be hospitalised due to respiratory infection and colds. Thus the hospital admission rate was markedly lower than expected and hence the study was insufficiently powered for the difference between the two groups in hospital utilisation to achieve statistical significance. This was despite the fact that the effect of the intervention was to virtually half hospitalisations and emergency visits. Additionally, participants reported that they are often sicker in the winter months and would have liked to have trialled the equipment during this period. Future research needs to be conducted over a longer period which includes all seasons. Silver Chain has recently embarked on a follow-up study to examine the intervention effects over the winter months.

CONCLUSION

This research has shown that remote monitoring of patient vital signs using telehealth equipment can produce significant costs savings for Australia while improving health outcomes for individuals living with COPD. In addition, improvement in participants' self management and control over their condition was evident, which is an important aspect of the telehealth model of care. Assisting individuals to be effective self-managers is a key component of quality care for people living with chronic conditions as it increases the likelihood of early detection of exacerbations, thereby reducing the likelihood of costly hospital admissions.

Apart from the obvious health and service utilisation benefits, this research showed that the telehealth technology was well received by the older people who participated in the trial and they expressed interest in wanting to use such a service in the future if it were available.

The benefits found in this research need not be restricted to individuals living in metropolitan areas. Rather, remote monitoring could be extremely beneficial to people living with chronic disease in rural and remote areas where access to health practitioners is limited and often requires significant travel. The equipment used in this research required only a regular telephone line and did not rely on fast speed broadband access which would currently preclude many rural Australians from being able to use this type of technology. Given that the infrastructure to support this type of service is already in place throughout Australia, a telehealth service could as easily be delivered in rural and isolated areas as it is in metropolitan areas

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