The impact of telehealth technology on user perception of wellbeing and social functioning, and the implications for service providers

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Abstract

The aim of the project was to evaluate the use of telehealth equipment in the homes of older community-dwelling people, and to review its social and economic impact. A mixed methods approach was adopted, involving interviews, observation and Depression Anxiety Stress Scales. Overall, the greatest benefit was apparent in those participants with a low familiarity with technology and low digital literacy, where changes in behaviours to prevent an exacerbation of their condition was possible. The user interface design reduced concern about using the technology. Changes achieved were through better compliance with medication and associated understanding of the impact on their vital signs and hence daily activities. This represented an improved health literacy and the economic benefits appear to be linked to that. Less benefit was observed by those who had been self-monitoring previously. A greater focus on specific conditions and improved self-management could strengthen the evidence for targeted economic benefits.

Keywords Older people, disability, rural, regional, elderly.

1 Introduction

Telehealth can reduce socio-economic costs by reducing travelling for face-to-face visits. The social and financial costs, as well as the associated detrimental effects on well-being for people in rural and regional areas, have been well documented in information systems (IS) literature,

with various technological solutions explored, not only telehealth (Boonstra & Van Offenbeek, 2010; Burmeister, Islam, Dayhew, & Crichton, 2015; Carlson, Farrelly, Frazer, & Borthwick, 2015; Scott, Richards, & Adhikari, 2015). Technology can be successfully applied in community-based patient care to enhance the capacity of nurses to deliver medications management for clients, resulting in increased efficiency of service delivery as well as staff and patient satisfaction (Georgantzi & Gheno, 2012; Towers & Tyler, 2014).

This article reports on a study of an installation of Tunstall Telehealth monitoring equipment, with a small selection of LiveBetter Services (formerly CareWest; hereafter called LiveBetter) clients in the rural and regional area about Orange, NSW. The study was undertaken to evaluate the use of telehealth equipment in the homes of older community-dwelling people, and to review its social and economic impact. It contributes to our understanding of the particular access needs of telehealth users for these regional and rural community-dwelling older people; following the literature that access to telehealth is a basic human right (Bradford, Caffery, & Smith, 2016; Morgan, 2008). With the technical dimensions of the information technology residing in the "background", the "foreground" focus was placed on the social perspectives associated with the use of this technology. The article begins with describing the context of LiveBetter and the telehealth equipment utilised by their clients. It then describes the methodology and findings, before discussing the results. The conclusion looks at the model features across the domains of accessibility, availability, acceptability, affordability, and adequacy and compares this new program with an established telehealth program (Saurman, Lyle, Kirby, & Roberts, 2014a) across these domains.

2 LiveBetter Services context

LiveBetter has offices in 25 locations across New South Wales including Bathurst, Bourke, Broken Hill, Dubbo, Griffith, Mudgee, Orange and Wagga Wagga. A not-for-profit organisation, LiveBetter offers support and advice to individuals, families, and communities across a broad range of services.

LiveBetter's 2015-2020 strategic plan clearly identifies its purpose as 'enabling people in regional Australia to live their best lives', and a key goal within this mission is to ensure that 'citizens in regional and rural communities have access to the services they require'. A significant issue for the organisation in driving this agenda is managing the large distances involved. The organisation's footprint covers roughly 70% of the State of New South Wales, a similar size to Kenya, and larger than either Sweden, Germany, or Italy.

One of LiveBetter's strategies in managing both the large distances and sparse population densities is to turn to technologies that will allow patients and practitioners to access each other, exchange information, and to develop appropriate care plans. Information systems which support these efforts have been shown to improve not only the health outcomes for patients, but the financial and time commitments made by individuals, their families, and the wider community (Boonstra & Van Offenbeek, 2010; Burmeister et al., 2015).

2.1 This study in the context of other telehealth studies

Overseas studies involving telehealth and related technologies have been shown efficacious in various ways (Burmeister, 2016; Jenkins & Draper, 2015; Niemeijer, Depla, Frederiks, Francke, & Hertogh, 2014; Pakrasi, Burmeister, McCallum, Coppola, & Loeb, 2015; Ritchie, 1997; Teipel et al., 2016). Similarly, within Australia, telehealth and other interventions for

community-dwelling older people and other age groups have been shown to be effective in supplementing delivery of health care, with positive impacts on patients' care and clinical staff (Bernoth et al., 2016; Burmeister, Bernoth, Dietsch, & Cleary, 2016; Burmeister & Marks, 2016; Hungerford & Fox, 2014; Soar, Capamagian, Denaro, Prentice, & Skinner-Smith, 2015; Warburton, Cowan, & Bathgate, 2013).

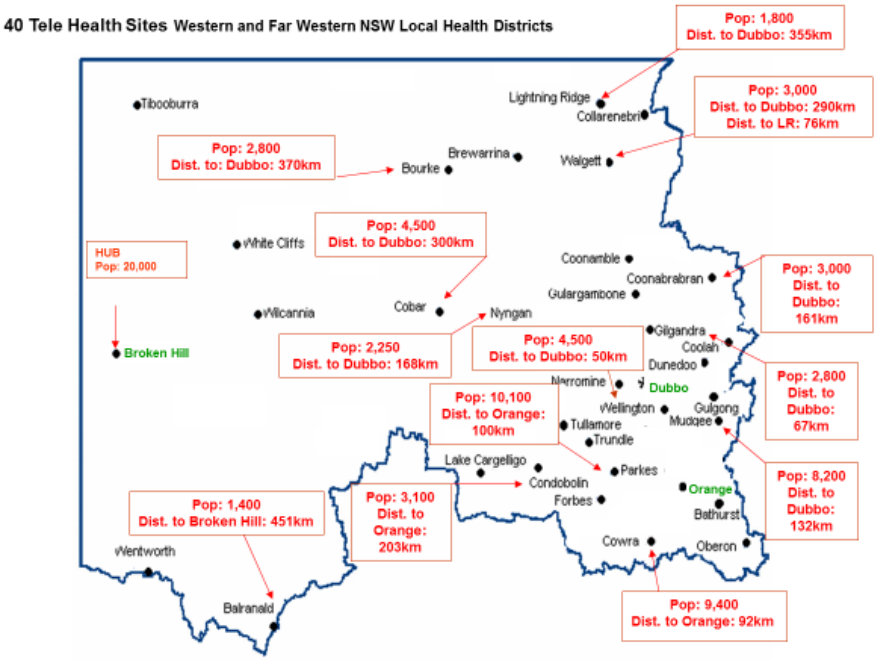

Figure 1: Telehealth sites and LiveBetter offices are located within Western and Far Western NSW.

Remote healthcare can supplement the delivery of care, providing support to clients and healthcare staff. The use of telehealth is well-established in Western NSW (Figure 1). For instance, the Mental Health Emergency Care (MHEC) program has been operating since early 2008, recording over 55,000 clinical contacts in the period between 2008 and 2013 (Saurman, Lyle, Kirby, & Roberts, 2014b). Serving a population of over 300,000, dedicated telehealth infrastructure is located at hospitals and health services in centres across 445,000 square kilometres of Western NSW (Saurman, Lyle, Perkins, & Roberts, 2014). In 2011, 46 of 48 rural emergency departments (ED) in Western NSW used the MHEC program (Saurman et al., 2011). This program has been found to be effective in reducing unnecessary transport and unnecessary admission to hospital (Saurman et al., 2011). Since its establishment, care protocols have become well-established and clinical outcomes are also well-researched (Saurman, Kirby, & Lyle, 2015). In addition to direct care to patients and families, the MHEC program provides support to general practitioners (GP), ED staff and other generalist government and non-government health staff in rural and remote areas. It has high patient and clinician acceptability and satisfaction levels, and is now viewed as a routine part of clinical care (Saurman et al., 2015; Saurman et al., 2011).

Tunstall Telehealth monitoring equipment was installed for at least 2 months in the homes of clients who consented to participate in the study. The monitoring equipment assessed a core set of measurements (such as blood pressure, heart rate, and weight) and obtained custom measurements depending on each client's health condition e.g. heart failure, chronic obstructive pulmonary disorder, hypertension and diabetes. The clinical/triage team from

LiveBetter ascertained the custom measurements for each client. Clients who consented to installation of the telehealth monitoring equipment were further given the choice to participate in the research.

Equipment description	Model	Brand	Manufacture Location
myclinic@home touch screen device	EP121	ASUS	Korea
Digital blood pressure monitor	UA-767 plus BT	A&D Medical	Japan
Omron Bluetooth Blood Pressure Monitor	BP792IT	Omron	Kyoto, Japan
UC-321PBT Precision Health Scale	9030600	AND	Japan
Glucometer Accu-Chek Performa	CE0088	Roche	Badan-Wurttemberg, Germany
Glucometer MyGlucoHealthWireless Meter	MGH-BT1	MyGlucoHealth	USA
Onyx® II Model 9560 Finger Pulse Oximeter	9560	Nonin	Plymouth, United States of America
ECG remosEKG	100BT	Vitaphone	Chemnitz, Germany
Forehead Thermometer	TD-1261	TaiDoc	Taipei County 248, Taiwan
Lung monitor with Bluetooth	40750	Vitalograph	Ennis Co Clare, Ireland

Table 1: Tunstall Telehealth equipment utilised during the LiveBetter study

Tunstall 'data sheets' from www.tunstallhealthcare.com.au provide the following information about this equipment. For instance, in Table 1 the myclinic@home is an individual user, wireless touch screen communication device designed to manage health interviews for up to 4 family members in a home environment. A range of Bluetooth-enabled vital sign peripherals interface with the system providing, for example, video conferencing capability. This system uses mobile or an internet connection to securely transmit data to the Integrated Care Platform Triage Manager. The two types of blood pressure monitors facilitate daily blood pressure readings. The pulse oximeter, which activates automatically when slipped onto a finger, measures blood oxygen saturation and pulse rate. The weight scales (UC-321PBT Precision Health Scale) are specifically designed for integration with the telehealth IS. The thermometer measures the patient's temperature, using infrared heat scanning skin over the user's forehead. The two glucometers enabled participants with diabetes to monitor and manage their blood glucose levels using very small blood samples.

3 Methodology

3.1 Research aims

The main research question addressed in this study was: What is the impact of the Tunstall telehealth systems on user perception of well-being and social functioning? Closely associated

with that was a secondary research question: What is the economic impact of the use of these systems?

These questions were answered in a mixed methods approach that focussed on an interpretivist, constructivist methodology. User perceptions were captured through interviews, and through the observations of the telehealth nurse who worked with each client during the study. User perceptions were also evaluated through the use of a national standard instrument, the Depression Anxiety Stress Scales (DASS), which is based on user perceptions about their well-being in the immediate past seven days prior to the administration of the DASS. The short-form version was used, which assesses the emotional and mental well-being of each participant, through 21 items to measure subscales for depression, anxiety and stress.

The purpose of the study of the Tunstall telehealth systems was to determine the social and economic values of this program to older community-dwelling Australians in the Orange region. This study focussed on the situation before the installation of the equipment and subsequent to the removal of the equipment. For this reason it took place over two phases. Approval to conduct the study was granted by the University's Human Research Ethics Committee.

Data collected using semi-structured interviews during Phase 1 allowed the researchers to understand the needs, attitudes, and skills of the clients using these systems. Each interview began with the administration of the DASS.

The focus of the Phase 2 interviews was to find out how well the telehealth program was helping clients meet the needs identified during Phase 1. Interviews in Phase 2 were conducted immediately prior to the removal of the telehealth equipment. As with Phase 1 interviews, each interview began with the administration of the DASS.

The interviews were conducted face-to-face and followed a semi-structured interviewing format utilising open-end questions and further probing questions. The semi-structured, in-depth interview format was selected to allow rich accounts of participants' experiences to be obtained. The interviews were conducted from September 2015 to July 2016 in Orange and the surrounding region. All the interviews were recorded and transcribed verbatim. This study of telehealth monitoring was not limited to technological monitoring alone. In addition to the technological monitoring, LiveBetter employed a nurse clinician to be a telehealth nurse during the study, whose responsibility it was to assist participants to use the equipment and who had regular face-to-face and telephone contact with participants during the study. She recorded her observations with clients during the study.

3.2 Recruitment

LiveBetter identified and recruited clients by convenience sampling. There were 18 participants for Phase 1 and 11 for Phase 2. Pre and post data reported here only relates to 11 of the 18 participants. Three couples, where both parties in the couple participated, chose to not always do separate interviews. For instance, one woman was not well enough to be interviewed separately for Phase 2, but she was present at her husband's post-interview and contributed to that discussion. Hence we consider we have data from 11 pre- and post-interviews, even though there are only 10 post-interview transcripts. Of the seven pre-participants who did not participate in the post-evaluation, one died and his wife chose to discontinue in the study, one was a couple and when the male entered a care facility both dropped out of the study, and three others gave no reason for discontinuing. Finally, it should

be noted that two participants had their spouses present during their interviews, but those spouses did not participate in the study themselves. For instance, in one case the person being interviewed was also the carer for her husband, thus requiring him nearby, to see to his care, if necessary.

Participant demographics were not a specific matter of data collection. However, 4 couples participated in which both members of the couple were also part of the study. 10 females and 8 males participated. Ages ranged from the low 60s to the low 80s, with the exception of one 51-year-old. Multicultural data was also not specifically captured, but participants included one Indigenous person, two from the Middle East, descendants from various cultures, but with all participants having been long term residents of rural and regional NSW. At the time of the study the majority lived in Orange, a few in the immediate region near Orange and the furthest participant lived 120 km outside Orange.

3.3 Analysis

The transcribed interviews were analysed using thematic analysis with QSR NVivo 10, a software package for managing data. The analysis of all interviews was carried out by the team leader. Early during the analysis process another member of the team independently analysed four interview transcripts, and near the conclusion of the Phase 2 analysis that same member independently analysed another 3 interview transcripts. The latter was for inter-rater reliability, with the two team members discussing all discrepancies in analysis, to ensure the reliability of interpretation of the results.

As regards the DASS analysis, in addition to comparing Phase 1 and 2 results to each other, the results were also compared to the Australian norms (Crawford, Cayley, Lovibond, Wilson, & Hartley, 2011).

4 Findings

Three themes emerged from the analysis of the interviews. They were Service Delivery, Social Impact, and Technology. The themes and categories are summarised in Table 2. Exemplary quotations addressing the research questions are given below, to reveal participant perceptions about this telehealth study.

Theme	Category
Service Delivery	Self-monitoring
	Health support
	Assisted monitoring
	Economic impact
Social Impact	Health status
	Reassurance
	Socialising in the home
	Socialising out of the home
	Treatment

Technology	Prior use
	Passive
	Attitude
	Post use
	Equipment
	Hardware
	Interface

Table 2: Themes and the categories within them arising from the LiveBetter study

4.1 Theme 1: Service Delivery

Categories within service delivery included self-monitoring, health support, assisted monitoring, and economic impact. Most participants valued the ability to have independence and control, but not all. Hence whilst there are many exemplars of self-monitoring, assisted monitoring was also needed.

> It good service because daily, ten o'clock in the morning, eleven o'clock - between ten and eleven I got a chance to check my data because sometime it is different. (Male)

> When I first had the equipment I thought, oh dear I'm not that ancient that I need that much help. Even though I'd had heart failure, and I thought well it won't be much use to me. But in the last few months I've found it's been excellent, because I've been able to monitor a bit more and (nurse clinician) said "If you can, take your blood pressure twice a day." But I've been taking it three times now, if I didn't have that equipment I wouldn't be able to do that, and they wouldn't be able to compare whether my blood pressure was dropping, or whether it was too high. So I've found that very good. And I've sort of changed my opinion about the whole thing, because I think it could be really very, very helpful as personally it gives you a bit more security. (Female)

Several participants complained about the difficulties and costs of changing batteries. One lady, who bought groceries weekly, had to forego groceries one week, because after paying rent, utilities and the Green Slip for her car, she only had 5 cents left. Clearly for someone in such a position, even the cost of replacement batteries, though small, is economically hard to manage.

4.2 Theme 2: Social Impact

Categories within social impact included health status, reassurance, socialising in the home, socialising out of the home, and treatment.

The health status of participants and/or their spouses impacted the ability to engage in social activities in and out of their residence. Health status was distinguished from treatment in that treatment was the reason for the telehealth monitoring, but in addition to that, e.g. diabetes, the person might also have other health conditions, such as impaired mobility that required the use of a walking frame, which might also affect their ability to socialise or necessitate medical appointments.

Reassurance is different from self-monitoring within the theme of service delivery. Self-monitoring gave participants the ability to feel they had a measure of control over their

condition. Reassurance is about the peace of mind that comes with knowing that when things go wrong, they can receive the help they require. For instance, one participant who died during the study had experienced a fall in his kitchen prior to the study. His wife was away and it was many hours before he could drag himself to the phone to ring for help. Even though his perception of telehealth monitoring providing alarm monitoring was incorrect, it still provided reassurance that if something untoward happened again, the telehealth monitoring might speed assistance getting to him. Other participants were indeed reassured and benefitted from the monitoring of their measurements to gain interventions before they might have become aware of the need for assistance.

Examples of socialising in the home and out of it follow. Noticeably for many participants, social activities revolve around medical support activities, and/or care package services, such as cleaning, cooking and mowing. First, in the home, including around the home, such as in the garden or on the farm.

> (Name) the heart failure clinic nurse comes around once a week. (Male)
>
> Neighbours come down at least twice a day to see how I'm going and then if I'm doing something they'll give me a hand to do it and all this type of business. So I go and help them too which I think that's part of life. (Male)
>
> Well sometimes I go in the Ute with him around the farm. I drive and he looks and opens the gate. And I prefer that, to be with him. Oh, we do it every day, every second day. (Female)
>
> A couple of days a week we have some friends up the road that pop in. My daughter or my son in law at least every second day. (Female)

Next, socialising out of the home:

> I'm a member of, like I said, an important men's group. That's – the idea of that is to get out of house. I have to go the doctors and go to mobility school which gets me out. The biggest problem with me was not being able to drive, because once you have a – your defib goes off you're not allowed to drive for six months. And mines gone off that many times I'll probably never get a licence back. (Male)
>
> I don't have much in the way of friends or social activities, or anything like that. I feel too bloody useless like I can't do anything because I can't walk properly, I can't use my hands the way I used to because they shake all the time. I want to try and do some walking up and down in the pool, but that's a bit expensive. (Male)
>
> Well we leave the house virtually every day for medical matters. Socially maybe once or twice a week for church. (Male)

The last was from a man who went into a care facility during the study period and therefore did not participate in the post-interview.

Some participants were very immobile. One man had started dental treatment immediately prior to a fall, and given that dentists do not do home visits, was unable to complete his dental treatment. Another example from a Phase 1 interview in September 2015 was that of a man who had only left his house once in 12 months.

4.3 Theme 3: Technology

Categories within Technology included prior use, passive, attitude, post use, equipment, hardware, and interface. Generally the interface was easy to use, even for participants with little prior use of telehealth systems. Attitudes towards technology use varied, but most participants welcomed the telehealth equipment and were willing to put in effort to learn to use it properly. A minority preferred a passive, minimalist approach, which did not involve much input from them. Exemplary quotations of participant views in this theme include the following.

> It said "Please take your ECG reading now", you take it and you press the button, and then you go onto the next one, and you finish the four. And then when that's all finished you just press the finish button, and then you just watch for the – I always watch for the signal little round piece – red piece that goes round and round to make sure it's gone to Brisbane. (Female)
>
> There's the blood pressure, then weight, and then ask me about salt, and how I feel today. But see it's only got better, worse, or something on the thing. Well it doesn't have in-between, so every time I press it I've got to press – same, same is the word. I just put the same because some days I feel in between it and I can't put worse down, but I could say not as well or something like that. (Female)
>
> That's the ECG … It will ring and you just hold it on your chest, and it does its business. It's pretty simple. (Male)
>
> The rough summary of that is the blood pressure one has worked probably ninety-nine percent of the time, at least all the time. The thermometer one has hardly worked at all and the little one over the finger (pulse oximeter). It has been very poor; it hasn't probably worked for the last month. (Male)
>
> Very good, because I don't know – I would never know me blood pressure was up without it, because you can't go up the doctor every day. I hadn't been up the street for about probably three years. So I find that very handy – very good. (Female)

As stated above, each Phase 1 and 2 interview was preceded by the administration of the DASS, and those findings are presented next. That is followed by the findings from the observations of the telehealth nurse.

4.4 Depression Anxiety Stress Scales

The Depression Anxiety Stress Scales (DASS) have been an accepted measure of populations similar to those in this study for over two decades, including in rural settings (Ciobanu, Brodard, Antonietti, Genoud, & Brandner, 2018; Crawford et al., 2011; Zhang et al., 2018). The DASS was administered with each interview (Figure 2). The depression subscale was observed to decrease from 9.56 ± 12.01 pre-telehealth to 6.33 ± 4.53 post-telehealth. The anxiety subscale decreased from 9.56 ± 5.75 pre-telehealth to 6.78 ± 4.66 post-telehealth. The stress subscale decreased from 9.22 ± 6.92 pre-telehealth to 6.11 ± 5.13 post-telehealth. The changes observed in the subscales were not significant.

The participants of this study scored higher in the depression and anxiety subscales pre- and post-telehealth compared with the Australian general adult population, which had a score of 5.02 ± 7.54 and 3.36 ± 5.07 for depression and anxiety, respectively (Crawford et al., 2011). For the stress subscale, the Australian general adult population scored 8.10 ± 8.40. Compared to

the Australian general adult population, participants of this study scored higher in the stress subscale before the telehealth intervention and lower after the telehealth intervention.

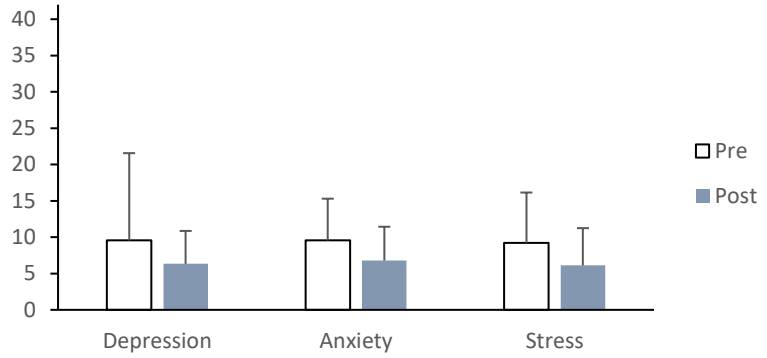

Figure 2. Pre- and post-telehealth DASS scores.

4.5 Nurse clinician observations

Four main themes that emerged from the nurse clinician's observations: chronic disease management; social connectedness; reduction in anxiety; technical difficulties and opportunities.

Firstly, the nurse clinician observed a favourable effect of telehealth monitoring on chronic disease management, likely associated with telehealth monitoring supporting self-management of symptoms associated with chronic diseases. Telehealth monitoring of vital signs combined with phone support and education from the nurse, improved participants' ability to recognise and appropriately manage symptoms and medical exacerbations. This was also associated with better medication compliance, resulting in improved vital signs during the study and an observed participant self-reported reduction in unplanned hospitalisations. These benefits were most noticeable in participants with multiple chronic conditions and/or higher severity of disease state.

The participants expressed to the nurse clinician that they valued their partnership with the nurse, who helped set health goals and provided advice for health-related decisions. Most importantly, this relationship provided access to a trusted nurse clinician. The participants would initiate conversations with the nurse clinician to clarify health information they had received from medical specialists and seek help to solve health-related issues. One client with heart failure stated that "the telehealth nurse has become one of the pillars in my health along with my General Practitioner (GP) and my Cardiac Nurse".

Telehealth played an important role in chronic disease management by facilitating interdisciplinary care. The nurse clinician shared information with and collaborated with GPs, nurse practitioners, registered nurses, pharmacists and home-care workers. Data obtained from telehealth monitoring influenced medical management decisions related to medications and identified the need for further investigations. In one case, data from the ECG telehealth peripheral contributed to investigations which led to a more invasive corrective procedure, significantly improving the participant's quality of life.

Secondly, telehealth monitoring also provided social connectivity, with 46% of the participants living alone. The nurse clinician called all the participants at least once a fortnight, including participants with stable vital signs and well-managed conditions. Participants expressed their

appreciation of these conversations to the nurse clinician. These phone calls provided social connection and reassurance of remote monitoring for older participants.

Thirdly, at the start of the telehealth monitoring study, the nurse clinician noticed that anxiety impacted the quality of life of most participants with chronic and complex conditions. The presence of multiple chronic conditions seemingly increased the participants' likelihood of psychological distress. As the study progressed, the nurse clinician observed a reduction in anxiety-related symptoms. This may be related to the participants' ability to monitor their vital signs, enabling them to self-assess their own physical state and thus decreasing anxiety associated with fear of physical deterioration or a health emergency. It may also relate to improved disease self-management and reduction in symptoms. However, ongoing reassurance from the nurse clinician was the most obvious influence on reducing anxiety.

Finally, the fourth theme that emerged from the nurse clinician's observations, revealed that there was diversity in the ability of the participants to use the telehealth equipment, with some requiring more technical support. Age did not seem to be a factor in determining ability, whilst previous technological experience may be a positive factor. For example, an 81-year-old participant with tablet and email experience found the telehealth technology intuitive. In comparison, another participant of similar age felt overwhelmed by the technology and withdrew participation during installation of the equipment.

The nurse clinician seemingly provided the most technical phone support during the first three weeks after installation. After this period, the participants felt more confident using the technology. They were also better able to troubleshoot technical difficulties independently or in consultation with IT support who could access their telehealth computer remotely to fix system issues.

Conditions associated with older age, including osteoarthritis and poor vision, seemingly restricted some of the participants' ability to independently replace the telehealth equipment batteries. This impacted on the role of the nurse clinician, who was at times required to attend the participant's residence in order to replace the batteries. The nurse clinician suggested that using USB or electricity charged equipment may provide a solution to this issue.

5 Discussion of results

Having presented the findings, this section relates them to the research questions this study sought to answer, and compares this new program with an established telehealth programs, such as that of Saurman, Lyle, et al. (2014a). The study sought to understand the impact of the Tunstall telehealth systems on user perception of well-being and social functioning, as well as economic impacts. This is somewhat different from many of the telehealth studies that precede this one, which are frequently focused on the tyranny of distance in rural and remote areas, or on cost savings, or on other factors, such as the effectiveness of accessing services (Bradford et al., 2016; Kruse et al., 2017; Saurman et al., 2015; Saurman, Lyle, Perkins, et al., 2014).

5.1 Perception of technology

In the initial interviews, several participants reported playing electronic games, using consoles such as Xbox or PlayStation, that younger family members might use, or other electronic devices such as an iPad, but did not regard these as using technology in the same way they viewed the telehealth monitoring equipment. Such disconnect between different types of technologies, and not relating learning about one type of technology to another, has also been

seen in other studies involving people in this age group (Morris et al., 2014; Pakrasi et al., 2015). One participant would join in games to interact with younger family members, but was not really good at it or necessarily interested in those types of action-oriented games. They reported not having clear expectations of the telehealth monitoring equipment because it was unfamiliar. Other participants, using electronic devices such as an iPad, were interested in hand-eye coordination and would play for that purpose, but were then drawn into successful play and advancement into higher levels of complexity. They would return to the device with that motivation as a distraction from other health related concerns, yet would still discount their understanding of technology. Entertainment was separated from monitoring health in regard to the importance of the technology. The commencing level of health literacy of participants understanding the relationship between measurement of vital signs and the interaction required with the equipment was something that changed substantially.

Confusion about how to work with technology was expressed by some participants as being uncertain or disinterested in knowing how to use equipment such as a personal content recorder or player. A television could be switched on or off, and channels changed, but several had not bothered to become familiar with video players when tapes were used, let alone digital entertainment. Many kitchens had micro-wave ovens, washing machines that had programmed settings, but these were regarded as household appliances and were not recognised as being technology, a finding supported in the literature (Kurniawan, 2008; Pakrasi et al., 2015). Thus there were frequent doubts expressed about the complexity of the proposed telehealth monitoring equipment, because participants did not see how learning about technology use in other areas would benefit them in learning about the use of the telehealth systems installed in their homes. A number of participants also had mobile phones, but these were used for basic communications, such as text or voice calls, and were not smart phones with more advanced features. Some participants, who had iPads, could also communicate with family members using Skype or Facetime, having been assisted with the setup of those programs by family members for easy use. The different reactions in part to technology depended on who had provided assistance in encouraging the use of the technology in the first instance, and the purpose it was used for. Communicating with family, and then friends, meant that a video call was not much of a technological leap from making a mobile phone call, or from using a landline. When a family member had programmed the calling numbers and all that was required was a few simple steps, easily remembered or written down. How participants had been moved from what they were familiar with to more advanced forms of technology seemed to influence perception and initial apprehension.

5.2 Adapting to self-managed health

In the initial interviews, several participants reported a relatively low level of awareness about self-management or interpretation of basic measures such as blood pressure, pulse rate, and blood oxygen saturation. When feeling unwell participants would consult a health professional. Understanding of medication, and its impact, was at the lower end of health literacy. This changed with the follow-up interviews. Several participants had been recording their telehealth measures – with a medium they were comfortable with, i.e. pen and paper – and had become comfortable in linking their measures to how they felt. Despite expressing their initial ambivalence with telehealth equipment during the pre-interview, most were converts and wished to keep the equipment in the post-interview. Exceptions were participants with diabetes who were self-monitoring blood sugar levels using their own

instruments even before this study. They reported little change in confidence in using technology as a consequence of the use of the telehealth intervention.

5.3 Economic impacts

The secondary research question sought clarity around the economic impacts of the telehealth study on participants. A number of participants who expressed some initial scepticism about the telehealth equipment, were very accepting of the equipment by the follow-up interview. This is in line with other studies that have introduced information systems to older people (Burmeister, 2010, 2012; Kurniawan, 2008; Morris et al., 2014; Vichitvanichphong, Talaei-Khoei, Kerr, Ghapanchi, & Scott-Parker, 2016). There seemed to be relatively few technical problems with reliability, but some follow-up reminders to measure and report according to the agreed schedule had occurred. The development of health literacy about the relationship between the vital sign measurements, medication management, and perceptions of wellbeing, meant that it was possible that less expensive equipment, and less frequent reporting, might enable better self-management after the study had concluded. There seemed to be a development of both confidence and pride in the self-awareness and management of their conditions. A perceptible increase in the social interaction and positiveness on the follow-up interview was acknowledged by the interviewers. It seems possible that less expensive personal monitoring equipment, such as fitness or activity trackers, could be used in conjunction with digital scales and automatic blood pressure monitors. Indicative prices for purchase of Omron Blood Pressure upper arm monitors range from $99.95-249.00, digital scales Soehnle Pino Digital Personal Scale $28-35, fitness trackers e.g. Fitbit Charge $169-230.

5.4 Preventable admissions/reduced emergent medical and health consultations

Several participants reported a stabilisation of their vital signs, such as blood pressure, with improved compliance with medications and the ability to interpret "good" from "poor" health days. When blood pressure and/or weight was up adjustments to activity ensued, with increased activity and socialisation on good health days, and adjusted activity levels on poor health days. Participants generally reported better awareness about how they felt based on the measurements, and that meant overall they felt that they were doing more. Participants reported taking ad hoc measurements, outside of designated reporting times, just to "check" how they were measuring up against their perceptions. This suggests an improved health literacy and an ability to self-monitor and better manage their daily living. Participants were more likely to discuss trends and/or examples of good/poor days and what they felt were different about them. Medications had been reviewed and adjusted, and several participants indicated that ad hoc medical and health consultations were not as frequent. They generally expressed a greater degree of comfort with their ongoing management of their condition than the health professional directed management previously. To what extent preventable admissions have been avoided could not be ascertained, nor could frequency of contact with health professionals be verified without access to personal health records, but participants were more confident in reduced reliance on direct visits to monitor their health status than previously.

6 Conclusion

Caution should be exercised in making definitive conclusions from this study based on the DASS measures used. The size of the sample and nature of the participants recruited into the

study make statistical inferences problematic. What can be observed is an improvement between the measures pre- and post-study, and a reduction in variation in the DASS subscales between measures, despite the lack of statistical significance. That could suggest some value in further investigation in a study where aiming for statistical inference was a design consideration. The reduction in anecdotal self-reported stress was a marked improvement compared to the generally higher depression and anxiety scales, and this seems to link to the reassurance that the tele-monitoring offered through greater health literacy and the empowerment associated with self-monitoring.

The participants from the age demographic in this study made it clear that comfort with technology was an issue in recruitment and participation, and the efforts of the LiveBetter nurse clinician to address these was important. Understanding the concerns of this group of participants could change how they might be introduced to the potential benefits of the monitoring and support offered by the telehealth systems. The role of the LiveBetter nurse clinician in supporting and assisting participants to develop their health literacy was significant and clearly remains one of the integral benefits many participants acknowledged. How future participants might be introduced to the technology, and the benefits of improved self-management, could facilitate a better fit between the health condition experienced and the life-style improvements that could result. The interface with the telehealth monitoring equipment was regarded by all participants as being very straight forward, easy to follow, and with few problems. Slight changes could result in fewer equipment maintenance issues such as battery performance and replacement.

The positive experience of the participants is evident in a number of ways, despite the numerical data from the DASS instrument. Those participants who were unstable in their self-management of their health condition previously, were assisted in the development of their ability to better self-manage medications and activity. This affected their mood and socialisation, both within their house and outside it. That participants, who previously had not been interested in the use of technology, could now see benefits in improving their daily living should not be underestimated. Several were now prepared to advocate for the use of telehealth equipment to others in similar circumstances who might be initially resistant. Considering the use of lower cost equipment to support self-management after the study is something that might be considered. It could also enable an expansion of the use of the resources to improve health status over a longer period of time to maintain the independent living of these ageing individuals.

In regards to the aims of the study, the telehealth systems introduced were successful for most of the community-dwelling older people who completed the study. Less benefit was observed by those who had been self-monitoring previously. The greatest benefit was apparent in those participants where changes in behaviours to prevent an exacerbation of their condition were possible, through either better compliance with medication, or better understanding the impact of medication on their vital signs and what that meant to their daily activities.

Regarding the social and economic impacts, again, the overall impression from participants was an enhancement to the self-perceived quality of daily functioning. Higher levels of self-reported socialisation, activity, and self-assurance seemed common. The economic benefits appear to be linked to that social improvement, but access to data held by others would be required to determine just how significant the improved self-management would be, to the range of health professionals the participants came into contact with in the lead up to the study

and beyond. The difference between frequency of personal visits and phone contact is another consideration. A greater focus on specific conditions and the ability to achieve stability in self-management could strengthen the evidence for targeted economic benefits.

Comparing the results of this study with a Mental Health Emergency Care-Rural Access Program (MHEC-RAP) (Saurman, Lyle, et al., 2014a) provides further insights into how technology can provide common benefits from both recipient and provider perspectives. The MHEC-RAP was designed to assist services provided to patients in locations where they did not have access to specialist services in a timely manner. The technology was designed to assist health professionals to extend their scope of support and to reduce higher costs being imposed on both the health care system and the individual. This purpose is somewhat different to the LiveBetter investigation of impact on the independence of the recipients, with the cost and impact being felt differently by a range of health service providers other than LiveBetter. This is where the study framework of accessibility, availability, acceptability, affordability and adequacy is useful in identifying who bears the costs and is advantaged by the benefits. Accessibility, designing for improved access and reduction of barriers, applies to both but in different aspects. The Tunstall telemonitoring equipment was rated by users as being easy to use and hence accessible, and the MHEC-RAP similarly by other health professionals. Availability, the ease of access, was limited in the LiveBetter study primarily by the cost of the equipment to both LiveBetter and the recipients, while the MHEC-RAP had greater accessibility, because the direct costs and benefits were received by the provider, while the recipients had improvements in the timeliness and quality of care. Acceptability, the meeting of needs, was apparent in both studies. Affordability, was different and arguably MHEC-RAP had a simpler but stronger business case for the same reasons as accessibility. The LiveBetter arguments are more complex and would require a larger scale study and broader cooperation to become viable to more recipients. The adequacy of the technology, the fit for purpose, was common to both studies. What was apparent with the LiveBetter study, would be the potential to stepdown to less expensive technology once health and digital literacy had been developed to levels enabling more independent self-management.

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