Evaluating the impact of 2nd and 3rd generation telecare services in older people's housing.

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Abstract
A controlled study compared 24 people with telecare living in sheltered housing (retirement housing) against a control group of 28 people. The intervention consisted of 2nd generation telecare equipment such as automatic flood or falls detectors; a 3rd generation lifestyle reassurance system; and an internet café. Overall no noticeable change in fear of falling was observed, however statistical significance was observed in the social functioning domain of the SF36 (7.5% difference p-value= 0.049). Positive trends were also evident in areas such as, increasing the amount of time spent out of the home, improved feelings of safety during the day and night (statistically significant), along with a reduction in the fear of crime. The Internet café was used by 25% of people for at least 20 minutes per week. The results would suggest that 2nd generation telecare systems and Internet facilities could be more widely used in service delivery but that lifestyle reassurance, as trialed, requires further development.

Introduction

Proponents of telecare suggest it could enable an increasing number of older people to live in a safer and more independent manner. However, in many respects it can be regarded as in its infancy with few mainstream and integrated systems in existence. In order to enhance service delivery decision making this two-year study sought to quantify the impact of telecare for people living in sheltered housing – also known as retirement housing, see Figure 1. Typically these provide independent, self contained homes for older people with a warden, or friendly neighbour, available to assist in general support needs.

Table 1[1] outlines the evolution of telecare generations. This study sought to provide data on the increasingly common, although often haphazard, deployment of 2nd generation systems. In order to inform a long-term deployment strategy consideration was also given to Internet facilities and the more speculative 3rd generation lifestyle reassurance systems.

Methods

The interventions took place in a single sheltered housing scheme. The choice of scheme was dictated by local service pressures but people living there had no prior involvement in telecare trials and there was no reason to expect their views would be unrepresentative of others in this cohort. Local experience suggested that recruiting control subjects would be difficult, therefore it was decided to approach 3 sheltered housing schemes to obtain an appropriately sized control group. Five schemes met the following criteria and the 3 most comparable to the intervention site approached.

- 25 or more homes on site.
- A warden service.
- Communal facilities such as common room.
- Closeness in age to residents at the intervention site.

In order to maximise the range and depth of data collected, quantitative and qualitative methods were chosen as follows:

- Falls Efficacy Scale (FES[3]): validated tool measuring a person's fear of falling.
- SF36[4]: validated tool to evaluate a person's health and ability to do everyday activities.
- Internally developed questionnaire: to provide general participant information and to record qualitative comments. At the intervention site specific questions on technology were also asked.
- Internet café questionnaire: developed internally to gauge usage and impact.

After obtaining appropriate NHS ethical and research governance approval, the SF36 and FES questionnaires were self administered and the internally developed questionnaires conducted by interview. All questionnaires were administered at baseline (prior to any intervention), and again at 6 and 12 months after telecare systems were installed. Further data on the number of telecare device activations was available from the onsite 24/7 warden service and control centre back-up.

Intervention

As no approved user assessment framework exists, all available telecare devices (2nd and 3rd generation) were offered free of charge to participants at the intervention site. However, rather than offer a long list, four telecare packages were defined and participants could select one or more packages, or any individual device (see Table 3 for further descriptions):

- *Security Package*: front door CCTV community television network; intruder alarm; flood detectors and extreme temperature detectors.
- *Falls Package*: fall detectors and automatic light switch (X-10).
- *Specialist devices*: wandering client system (alert if the front door is opened at night), epilepsy bed monitor, strobe light alert, vibrating pillow alert.
- *Lifestyle reassurance*: bed and chair occupancy devices, passive infra-red (PIR) movement detectors, door contact monitors, and electrical usage – the 3rd generation system.

In was soon established that the 3rd generation system did not function as expected and alerts indicating an intervention would be beneficial could not be accurately provided. It was therefore decided to collect data, and retrospectively analyse it when major health or care events took place (such as hospital admission), in order to test the potential of the system to visualise changes in activity prior to such major health events.

After consultation with residents the laundry room was refurbished with 3 internet enabled computers and the laundry facilities moved to two smaller rooms which were no longer being used.

Results

At the intervention scheme 31 of the 35 occupants consented for the telecare element and 28 the Internet café. For the control group 68 people were approached across 3 sheltered housing schemes, 38 of whom gave consent. At the end of the 12 month monitoring period 52 participants (24 intervention; 28 control) completed all baseline, 6, and 12 month questionnaires; brief details are provided in Table 2. Reasons for withdrawal from the intervention group were: 2 changed their minds prior to installation, 2 did not complete either the 6 or 12 month questionnaires as a result of illness, 2 withdrew without giving a reason, and 1 died.

Table 3 provides details of the telecare equipment installed. During the 12 month monitoring period wardens at the intervention site received 110 telecare alerts from 2nd generation devices. The majority occurred in the first few months, especially from the intruder alarm as occupants became familiar with its use. Over time the frequency of alerts reduced from 89 in the first 6 months to 21 in following 6 months. Of the 110 alerts, 22 were considered appropriate by the wardens (11 in each 6 month period), for example:

- Flood detectors recognising dangerous levels of water on the floor and one case where a washing machine leaked.
- Bed sensors indicating users who did not return to their bed during, what were agreed as, night-time hours.
- Extreme temperature detecting the cooker or grill being left on by mistake.

At baseline, the average values for the FES and SF36 differed between the arms of the study. Independent t-tests were conducted to measure the differences observed and, consequently, data adjusted at baseline using the results from an ANCOVA analysis (regression coefficients and study population average baseline values). The results presented for the FES and SF36 are derived from this statistically adjusted data.

Table 4 indicates that no trend was evident for the FES. A within-subject, repeated measures, two factor ANOVA calculation over the baseline, 6, and 12 months time periods indicated a p-value of 0.885, indicating no significant difference.

Table 5 highlights that no significant difference was observed for 8 of the 9 SF36 domains. However, the Social Functioning domain showed a statistically significant difference, with scores 7.5% higher in the intervention group ($p=0.049$) over the 12 month evaluation period, suggesting a beneficial impact.

Table 6 suggests other important trends, particularly for feelings of safety, which was statistically significant ($p=0.008$).

For the 3rd generation system there were examples where changes in activity could be visualised prior to a major health or care event; however the reverse was also true. Fig 2 presents an analysis conducted by the lifestyle reassurance system where a general decline in activity from one of the participants can be observed over an extended period of time prior to a hospital admission (week 40). The Nutrition Index is a summation of device activations from the kitchen PIR, kettle etc. However, in the second example, Fig 3 shows a participant who received 7 medical interventions, but the system revealed no noticeable changes in activity.

Of the 28 people who gave their consent for the Internet café evaluation, 25 completed the questionnaire and 16 used the facilities. At the end of the 6 month evaluation period 9 people were using the computers for a minimum of 20 minutes per week.

Discussion

Installation

Installing the telecare systems and establishing the Internet café was a significant task in terms of tendering, contracts, user consultation, training and so on. It was technically easier to activate all of the telecare systems at the same time. However, as they became operational there was a noticeable impact on staff time. This has important implications for workload and a phased approach to installation, installing a small number of users or individual device types at a time, would have been more appropriate.

Telecare alerts

The 2nd generation devices detected potentially dangerous, and perhaps in some cases even life-threatening, incidents on 22 occasions. Eighty-eight inappropriate alerts were generated and, as there is probable link with subsequent user intrusion/abandonment, this is of concern. However, the number of inappropriate alerts may be overstated as a technical *false* alert is not the same as a user-perceived *false* alert. For example, the intruder alarm raised many *false* alerts, yet technically these were appropriate; it was just that participants had forgotten to turn the alarm off when they returned home. Technological developments are required to minimise both technical and perceived false alerts.

An interesting comment by service providers was that the presence of the devices acted as a reminder, for instance not to leave taps or the cooker on. There is also the possibility that having raised an alert, the ‘embarrassment’ of a service provider call

could act to reduce the likelihood of such events occurring again. This hypothesis merits further investigation.

Outcomes
There was little or no impact on fear of falling. This may be because the tool was not sensitive enough to detect subtle changes, that the sample size was too small, or that the interventions had little effect in this area. Comments received from participants suggested many were unhappy wearing the fall detector, and the automatic lights also did not perform as required (as they left a faint light-bulb glow which participants found annoying). This may have led to subsequent abandonment by some users.

Statistical significance was found in the SF36 social functioning domain. However, as with other aspects of the study, it is not clear whether this was a consequence of one specific intervention or the overall combination of interventions made at the site.

Table 6 shows that, compared to the control group, the intervention group reported positive trends in areas such as time spent out of the home and improved feelings of safety during the day and night. These quantitative results were supported by qualitative participant comments.

3rd generation developments
Few studies have sought to evaluate the performance of 3rd generation lifestyle reassurance systems despite numerous commercial systems being available. The system trialled was disappointing in its performance from a user and service provider perspective. Real-time data gathering and analysis were provided by the system but it was not possible to automatically generate alerts from observed changes in activity, therefore making the real-time component unusable for service delivery.

In practice therefore the system did not intervene but instead provided data for subsequent evaluation. Participant diaries were provided and whenever a known medical intervention occurred the graphical information, as shown in Figs 2 and 3, was retrospectively reviewed. It is encouraging that Fig 2 suggests an automated system should have been able to detect behavioural changes. Yet Fig 3 suggests further developmental work is required. In particular, enhancements are required to:

- establish an automated approach which conforms to appropriate technical and service standards.
- define the optimal user needs match to device fit and environmental configuration.
- understand the cases where changes can be detected and those that cannot.
- determine the point at which a medical, or care, intervention would be beneficial.
- provide automatic adaptation to changing user behaviour – minimising false alerts and maximising response effectiveness.
- develop a reliable feedback mechanism to users, carers, and health/care professionals.

These and other enhancements are the subject of ongoing research with which the authors are involved.

Conclusions
There are relatively few studies which quantify the impact of telecare on health or care interventions, especially comparative studies of telecare against present service delivery. The dearth of data on issues such as cost and clinical effectiveness is a major reason why the promise of telecare has not become a service reality[5]. In this study, the 2nd generation system was reliable, potentially dangerous situations were detected, and positive feedback given by users. Participants also embraced the Internet café. Results suggest that there was an overall positive effect on outcomes of importance for older people, such as feelings of safety and security and on social participation, suggesting that greater deployment may be appropriate. Although larger scale studies are required to confirm these findings.

The 3rd generation system trialed can really only be described as developmental in nature. When commissioned it was, and still is, being sold as a commercial solution, but without attention given to the enhancements suggested, the service/clinical benefits of wide-scale deployment are questionable. This raises concerns at a much wider level. It is highly likely that 'un-evaluated' telecare *solutions* are being deployed and people's care packages modified as a consequence of technology. This may, in some cases be exposing vulnerable people to increased risk. If telecare is to mature and truly address user needs, greater efforts are required to conduct appropriately powered comparative studies so that service commissioners can make informed decisions.

Acknowledgements
The authors are grateful to all participants and to Doncaster Neighbourhood Renewal Fund for funding this trial.

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Table 1: The evolution of telecare generations.

Generation	Description	Example
1st	Technically simple systems with no embedded intelligence and entirely reliant on the user activating calls.	Pendant trigger, often warn around the neck.
2nd	All the features of the 1st generation but also providing some level of intelligence and automatic detection of limited alert conditions.	Automatic fall detectors, carbon monoxide, flood.
3rd	Encompassing functions of 2nd generation systems and adding additional support capabilities such as lifestyle reassurance* and the introduction of virtual neighbourhoods.	Detecting changes in behavior that automatically indicate intervention would be beneficial. Also, include interaction, perhaps through video, in support groups, virtual shopping over the internet and so on.

* Historically called lifestyle monitoring but focus groups with users has suggested this term raises issues of 'big brother' and control, whereas lifestyle reassurance emphasizes a 'safety net' approach and is considered a more descriptive and acceptable term[2]

Table 2: Details of the intervention and control groups.

Group	No. Females (Avg age ± s.d.)	No. Males (Avg age ± s.d.)	Total No. (Avg age ± s.d)
Intervention	13 (74.2 ± 9.7)	11 (72.1 ± 12.6)	24 (73.3 ± 10.9)
Control	17 (78.8 ± 6.9)	11 (74.8 ± 8.0)	28 (77.2 ± 7.5)

Table 3: Telecare equipment chosen by participants (n=29).

Device	Description	Uptake by participants	
		Number	Percentage
CCTV	Provide video image of front door on television screen	29	100%
Intruder alarm	Security to dwelling	29	100%
Flood detector (x2)	Detect flood in kitchen or bathroom	29	100%
Extreme temperature detector	Early detection of fire hazard when cooking	26	90%
Fall detector	Warn device to automatically detect falls	8	28%
Automatic light switch	Turns main room light on automatically when getting out of bed	6	21%
Bed occupancy	Alert and long term monitoring	15	52%
Chair occupancy	Alert and long term monitoring	11	38%
PIR movement detectors (x5)	Movement patterns	29	100%
Door usage (x3)	Cutlery draw, food cupboard, and fridge	27	93%
Electricity usage (x2)	Kettle and television	27	93%

Table 4: Adjusted FES scores for intervention and control group.

Group	Adjusted baseline	6 months	12 months
Intervention (n=24)	67.3	67.7	67.2
Control (n=28)	67.3	70.8	65.5

Table 5: P-values of the differences between the intervention and control groups (statistically adjusted at baseline) for the SF36 domains during the 12 month evaluation period (n=52).

SF36 domain	Baseline		6 months				12 months				p-value*
	Con	Int	Con		Int		Con		Int		
	score	score	score	s.d.	score	s.d.	score	s.d.	score	s.d.	
Physical Functioning	51	51	51	17	48	12	47	22	49	11	0.840
Role Limitation: Physical	50	50	51	30	57	28	46	36	57	26	0.292
Role Limitation: emotional	66	66	67	34	72	23	62	33	68	22	0.445
Social Functioning	73	73	64	25	77	15	67	28	75	17	0.049
Mental Health	74	74	75	15	74	12	74	17	76	14	0.878
Energy/Vitality	56	56	49	19	55	14	52	17	54	15	0.273
Pain	64	64	68	20	69	18	66	24	69	19	0.702
Health Perception	55	55	54	16	53	15	55	19	52	12	0.523
Change in Health	47	47	48	17	43	26	45	17	43	19	0.528

* p-values represent change over the 3 time periods.

Table 6: Trends within the internally developed questionnaire (comparison over the 12 month evaluation period)

Issue	Trend
Frequency of outside visits	The intervention group maintained the average number of outside visits at 5 per week. The control group reduced from 5 to 4.6 (p=0.582).
Time spent out of the home	The intervention group increased from an average of 3.6 to 4.0 hours per week. The control group reduced from 2.6 to 2.4 (p=0.096).
Feelings of safety	During the day the intervention group increased by 1% and the control group decreased by 1% (p=0.027). For feelings of safety at night the change was 3% and –7% respectively (p=0.008).
Fear of crime	For the intervention group fear of crime reduced by 10% and increased by 6% for the control group (p=0.743).

Figure 1: The intervention site

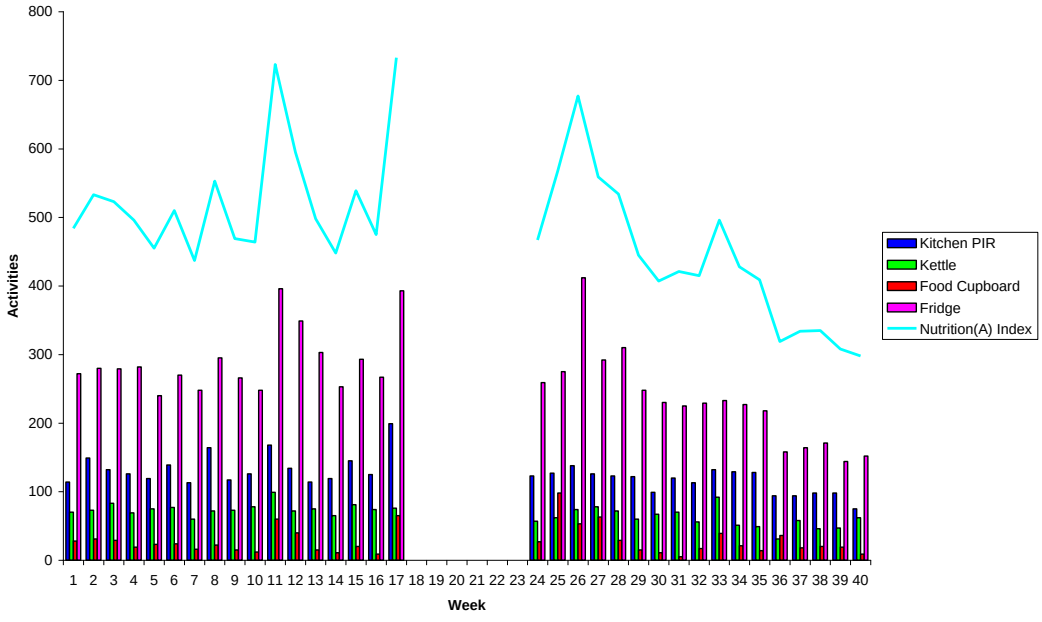

Figure 2: Positive case study where a general decline in the overall index can be observed (missing data between week 17 to 24).

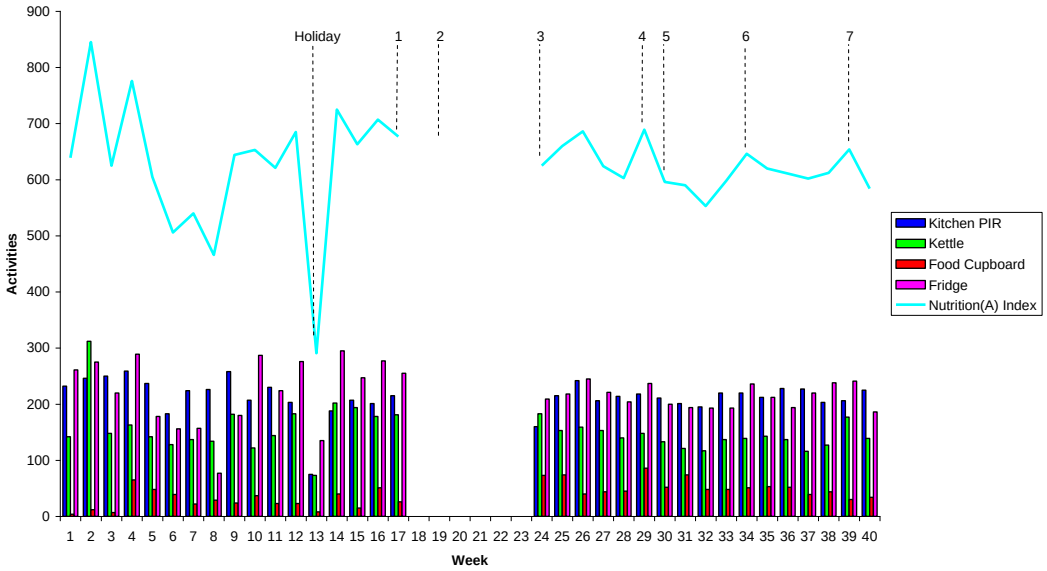

Figure 3: Unclear case study where no trend in the overall index can be observed despite repeated healthcare interventions (missing data between weeks 17 to 24).