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Liverpool Telecare Pilot: telecare as an information tool

Mark Buckland
Senior Researcher, British Telecommunications plc, Ipswich, Suffolk, UK

Barbara Frost
Occupational Therapist, Community Services Dept., Mossleyhill Hospital, Liverpool, UK

Andrew Reeves
Researcher, British Telecommunications plc, Ipswich, Suffolk, UK

ABSTRACT

The role of telecare systems is normally seen as identifying, and drawing attention to, situations of concern in the homes of service users. While this may currently be the primary reason for deploying such systems, the scope of telecare should not be limited to such an alarm generation role. The role of telecare in enhancing community-based care provision may be broadened by using similar, or identical, technology for providing relevant information to the carers of service users. In this paper we present a technical overview and discussion of an information provision approach to telecare which was trialled as one aspect of a pilot service in Liverpool, UK. The service used data collected by the telecare system to produce visual daily behavioural profiles and presented these to carers. The recipients for these profiles included social workers, occupational therapists and relatives of the service users. In this paper we discuss the visual profiles together with the benefits offered by such an information provision approach, including the perspective of a occupational therapist based in Liverpool.

Keywords: elderly, ICT, telecare

Introduction

In response to the growing demand for care arising from the increasing elderly population,[1–3] British Telecom (BT) and Liverpool Direct Ltd are working with Liverpool (UK) City Council to pilot telecare solutions for supporting care provision to service users from their social services department. The Liverpool solution was designed primarily to act as an intelligent alarm system, drawing attention to possible situations of concern within the homes of the 21 pilot service users. However, the ambient sensor devices deployed to meet the primary objective also offered the secondary benefit of collecting sensor data which depicted the in-home movements of the service users. It was realised that this information itself might be of value to specific individuals within the care networks of these service users. The alarm aspects of the pilot are discussed elsewhere[4] and this paper focuses on the use of telecare as an information provision tool.

Technical overview

As a Liverpool Telecare Pilot service user conducts their daily life, two different kinds of sensors are used within their dwelling to detect their activity: (1) passive infrared (PIR) motion detectors, and (2) state change sensors, the latter detecting situations like bed occupancy, toilet flushing, fridge/freezer usage, and doors or windows opening and closing. A third sensor type, which detects temperature, is also used. These sensors, with the exclusion of the temperature sensor, are

wirelessly connected to the residential monitoring unit (RMU) which is located in the service user's property. The RMU performs several functions including hosting the telecare client software, enabling network connectivity and providing an uninterruptible power supply to maintain short-term power in the event of mains power failure.

The real-time analysis of sensor data, required for alarm generation, is carried out by the telecare client software within the RMU. However, the raw sensor data collected by the RMU are also securely transmitted in real time over a broadband connection to central servers for storage and periodic analysis. The RMU provides some data storage capability itself and, in the event of failure of the broadband connection, the in-home device continues to log sensor data and uploads them when the connection is restored. All data are time-stamped on arrival at the RMU so that, if necessary, the server can reorder the data.

When data are sent from the telecare client to the server, the sensor data are stored in a Structured Query Language (SQL) database. Every morning, this database is queried by a Java application to obtain all the sensor firings and also any alarms that have been raised during the previous 24 hours. The Java application was developed to represent the sensor data graphically as a 'behaviour chart', or 'behavioural profile'. The behaviour chart has the sensor name on the *y* axis and the time of day when it fired on the *x* axis. Figure 1 shows an example of this type of graph. The majority of sensor events are PIR movement sensor firings, and these are shown by a circle and a line connecting them to the next PIR event. Other readings shown are state change sensors being turned 'off' (indicated on the original chart as a vertical line) and 'on' (indicated on the original by a shorter vertical line). Any alarms in the 24-hour period are also shown as small circles, with the name of the alarm on the *y* axis.

After the Java application has performed the necessary SQL database queries, the graphs are created for the required service users and stored locally at the server. They are then automatically converted to portable document format (PDF) and emailed to the appropriate carers. Email delivery (information push) is preferable over web delivery (information pull), as the graph can be sent to the recipient as soon as the data and graph are ready. For convenience the profiles ran from 9 a.m. to 9 a.m., allowing a complete night-time period to be represented on a single chart.

The example profile in Figure 1 shows a service user who has had an active day, went out for about one hour at lunchtime, and had an alarm raised at 6.30 p.m., warning that the fridge door had been left open for an unusual length of time.

Use of behavioural profiles

In addition to giving a general feel for the activity of a service user, one of the most interesting uses for the daily profiles is in indicating sleep patterns. Sleep can be a good indicator of well-being and the first use of the daily behaviour charts was at the request of an informal carer who had concerns about the sleep pattern of the relative for whom they cared.[5] The carer had speculated that disturbed sleep might provide an explanation for the different behaviours of the service user on different days, for example restless or calm. The example given in Figure 1 shows an instance where the service user went to sleep at 11 p.m. and

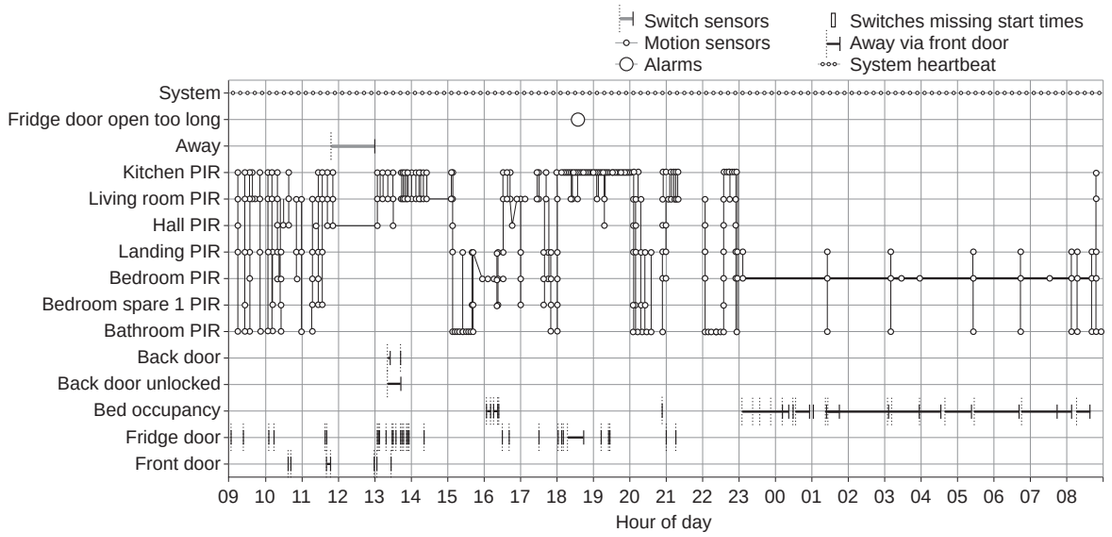

Figure 1 Example daily behaviour chart

got up at 8.45 a.m. During the night they awoke five times to visit the toilet. By combining the chart with their own knowledge of the service user, a carer can ascertain the level of severity of this sleepless night. The information given by the profile not only tells the carer why the service user might be tired or irritable the following day, it shows the carer that the service user's toilet visits might be indicative of a problem that could require medical intervention. This kind of patient monitoring enables the proactive detection of medical issues in a more timely manner than waiting for the next scheduled general practitioner or specialist appointment, which may not occur for some time after the initial 'warning' event. The proactive approach could accordingly contribute to improving the overall health and well-being of a service user. A further benefit of the early detection of medical conditions is that it could also help to prevent a relatively minor condition from becoming an acute problem and needing a higher level of social care or perhaps a hospital stay.

It is clear from this discussion that the use of telecare for gathering information on the lifestyle of a service user raises a number of ethical issues. The type of information potentially available from telecare systems provides a level of detail about an individual's daily behaviour, in their own home, which has been previously unavailable. The acceptability of using telecare systems to gather such information largely depends on the specific need and circumstances of its users. A discussion on the ethical implications of telecare is beyond the scope of this paper, but the Department of Health (UK) has issued a factsheet[6] outlining ethical considerations around telecare and literature exists[7–9] which also provides a useful introduction to the topic.

Informal carer use

Within the Liverpool Pilot the daily behavioural profiles were shown to be of use to the family members of one particular service user. Family members often perform vital roles in the care networks of frail or vulnerable service users, and the involvement of informal carers in the development of new approaches to telecare is essential. In the pilot, the son of a service user with dementia requested the daily graphs as they were 'good for looking at my father's overall condition, making sure he is safe and keeping an eye on his wanderings during the night'. Talking about the behavioural profile approach, he said, '... [it] helps us use the telecare data in a very meaningful way to decide if and when to place my father in a home or for him to live with us. The graphs provide peace of mind, that he is safe, and if there is a pattern of wandering behaviour we can nip it in the bud. With regards to medical benefits, we can judge whether future care needs to be adjusted, for example, the best time for the ''night'' visit by a carer, i.e. when my father gets help getting undressed for bed'.

Technical use

Within the context of the Liverpool Pilot the availability of a graphical approach to data representation also served as an invaluable tool for the developers of the system. For example, the telecare team used the graphs for confirming the correct operation of the in-home sensors and for assisting in the identification of maintenance needs. The developers of the telecare system preferred an applet (a Java application available in a web browser) version of the application as it offered them more flexibility over the data that was visualised. The applet allowed them to select different date ranges and different service users for viewing. The applet then performed the necessary database query and displayed the graphical representation of the sensor data inside the web browser of the user, in a form similar to that of the daily emails. This version of the application was also found to be useful for considering the origins of specific alarms, as it allowed historical alarms to be displayed alongside the relevant sensor events in a form that was easy to interpret.

Pre-processing of the sensor data

The discussion thus far has centred on the displaying of raw sensor data. However, an additional level of processing was performed on the sensor data to infer three specific scenarios: 'system ok', 'away' and 'visitor'.

The 'system ok' algorithm was developed to provide an indicator that a particular RMU was receiving and transmitting data as intended. This is useful to both the carers and the developers of the system, as in situations when the service user was away for a whole day it was difficult to quickly ascertain if the absence of sensor events was due to the service user dwelling being unoccupied or due to a technical failure with the collection and transmission of data. The solution which was implemented used data provided by the temperature sensor, which was set to record the ambient in-home temperature every 20 minutes, and displayed this as an 'alive' ping or 'heartbeat' on the chart. This approach was considered to provide a good indicator of the correct functioning of the RMU.

The 'away' algorithm is used to identify periods when a dwelling is unoccupied. The algorithm uses data from the front and back door sensors, combined with a threshold for lack of activity in the dwelling. The algorithm is also designed to differentiate the 'away' situations when the service user has left the

front or back door open from those where all doors are closed. This was at the request of a carer who was concerned regarding possible wandering events of a service user with dementia. The 'visitor' algorithm uses a statistical approach to identify periods when the service user is likely to be in receiving a visitor. Both the 'away' and 'visitor' events were shown on the behavioural profiles trialled in the pilot.

Telecare from an occupational therapist's perspective

In addition to informal carers, the Liverpool Pilot also worked with professional carers and, in particular, an occupational therapist (OT) from a community team within the local National Health Service (NHS) trust. The OT was part of the Older Persons Mental Health Service in Liverpool. One possible role for telecare is in helping to prevent, or delay, a move to the next level of care support, such as sheltered accommodation or nursing homes. This aligns with the role of community teams, and OTs in particular, who are committed to maintaining people in their own homes as independently as possible for as long as possible. The community teams work with people who are over the age of 65 with a diagnosis of a mental health problem or dementia, as well as the many physical problems related to old age.

The OT saw a clear benefit that telecare could provide for her work. She explained that:

> Moving people with dementia, even in the early stages, to safer housing such as sheltered accommodation or 24-hour residential care can cause distress. Moving can also increase the level of confusion, as they are often unable to learn new information, which then has an impact on their ability to adapt to new surroundings. Being in familiar surroundings with established routines helps to minimise the effects of dementia.

She also felt telecare was applicable to the elderly in general, explaining that:

> With the frailty that comes with old age there are increased risks when living alone. Anything that helps to reduce these risks is of immense value to the people the community teams work with and their carers, especially a system that requires no direct action on the part of the service user. One significant advantage to the provision of community services in the future would be if new properties being built to house older people could have this technology installed as an integral part of the building programme with the facility to switch it on as and when required.

Healthcare use of daily profiles

The experience of the OT with the Liverpool Pilot was that having access to the previous day's activities of a service user was valuable in different ways. For example, in the case of an elderly woman and her family members, knowing that the elderly mother is sleeping (or at least remaining in her bed) throughout the night is very reassuring. The family's main worry is that the mother might get up during the night and fall downstairs again, as the previous fall resulted in major surgery and a long stay in hospital. The elderly mother's daughter is the main carer whilst also caring for her own husband who is tetraplegic. Having the telecare system installed in the carer's mother's house enables the daughter to sleep at night knowing that if anything untoward should happen she would be alerted almost immediately.

Another service user, a 92-year-old lady who lives alone and has no immediate family, relies on the good nature of her next door neighbour to fill in gaps in her care package. She is fiercely independent and does not want a great deal of intervention. The telecare system allows the neighbour to carry on with her employment and to look after her own family while being always available to contact via the telephone should an alert be raised.

Having the daily profiles provides evidence for ongoing risk assessments, allowing the community teams to monitor changes in service users' patterns of behaviour, which can help to predict required changes to treatment plans or care packages. When people with dementia develop an infection it will temporarily increase their level of confusion: for example, a sudden increase in visits to the toilet may indicate a urine infection. The quicker the infection is dealt with, the quicker the added confusion resolves. A service user with memory problems might not recognise that their pattern has changed and therefore would be unable to alert anyone to the problem.

After her involvement in the pilot, the OT's perspective on telecare was that:

> People are generally living longer than before and so there are greater numbers of elderly people needing support and a decreasing number of facilities in which support is provided. These demands indicate that technology is more important than ever in assisting both health and social services in supporting people in their own homes. In many cases people will agree to go into care reluctantly because they know the family are worried about them being at home alone. Having the telecare system not only gives the families peace of mind but also the older people themselves feel more confident on their own knowing that if they need help it will be summoned for them automatically.

Further work

Building on the BT/Liverpool collaboration, work has also been initiated into researching the next generation of telecare systems. The system described here was originally designed to shift the emphasis for the raising of alarms from the service user to the system. Then, through the daily behaviour charts, the next step was taken towards migrating the system from solely being a crisis safety net towards an assessment tool for the provision and planning of individuals' care. The behaviour charts only show a snapshot of activity, and the next stage is to examine if long-term changes in the well-being of an individual can be identified so that interventions may be scheduled proactively and crisis situations prevented. To examine this more detailed approach to information provision, two of the Liverpool Pilot service users have now received enhanced sensor sets and experimental algorithms to endeavour to provide a richer understanding of their behavioural patterns and their activities of daily living. This forms part of the work undertaken by the UK Department of Trade and Industry (DTI) Care in the Community Virtual Research Centre which is co-funded by the DTI and BT.[10,11]

Conclusions

The Liverpool Pilot showed that the implementation of an intelligent alarm system that remotely monitors service users and contacts carers upon an alarm condition is both technically feasible and desired by healthcare professionals. However, the pilot also had a role to play in beginning to explore the use of telecare as an information provision tool for carers. To realise its full potential, telecare must go beyond an alarm system and explore other ways in which it can support care provision. The work in Liverpool was a small-scale pilot, and there remains an amount of political work and benefits analysis required to encourage the wider adoption of telecare systems by both the private and public sectors. In the UK, central government has demonstrated support for telecare, including the introduction of Preventative Technology Grants[12] and the production of a National Framework Agreement for Telecare.[13] These steps are likely to prove critical in helping to drive telecare towards more mainstream deployment.

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CONFLICTS OF INTEREST

None.

ADDRESS FOR CORRESPONDENCE

Andrew Reeves
BT Group
Orion Building 1st Floor pp4
Adastral Park
Martlesham Heath
Ipswich
Suffolk IP5 3RE
UK
Email: andrew.2.reeves@bt.com

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