Home-based Telehealth Devices and the National Broadband Network (NBN): Reflections on Technical Feasibility versus Patient Need

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Abstract. Australia is deploying a $30bn National Broadband Network for all Australians by 2021. At the same time, the ageing population has led to a focus on finding new ways to support patients to live independently for longer in their own homes and to support them to self-manage. While broadband connected home-based telehealth appears to hold promise, there remain few examples of successful implementation. There is also limited insight into how technical feasibility interacts with meeting genuine patient needs in home-based environments. This paper describes a telehealth platform called MediStation designed to support patients' in home-based environments. It confirms reliable home-based telehealth devices are feasible and usable by patients. However failure to holistically understand patient needs means these devices tend to support compliance rather than self-management. This will not contribute to the ability of patients to live independently for longer in their own homes or to sustained use of these types of devices.

Keywords: Broadband, telehealth, MCRDR, patient self-management.

1 Introduction

Australia is the world's sixth-largest country by land area yet has a population of only 23 million people. As a consequence, maintenance of equity in access to public services is a major challenge for Australian Federal and State governments. In the delivery of healthcare services this presents some unique challenges because of the Australia government's commitment to a universal healthcare system available to all [1]. It is anticipated that Australia's NBN will provide an advanced and reliable

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nation-wide platform through which homes, doctors surgeries, pharmacies, and other healthcare related organizations can be connected to support improved access to healthcare services [1]. The most important anticipated benefits from this connectivity are around patient data and supporting patients in their own homes. This is tied to the Australian government's announcement in July 2012 of its commitment to spend $466.7m for the implementation of a PCEHR (personally controlled electronic health record). Australia's national e-health transition authority (NEHTA) responsible for the development and deployment of the PCEHR anticipated that is will enhance the quality and the timeliness of available healthcare information, delivering substantial benefits to consumer, healthcare provider and the healthcare system as a whole. Moffatt and Eley [2] report that it is also anticipated that the NBN will support reductions in the costs associated with health care for both hospitals and patients as telehealth is adopted, particularly for those in rural, regional and remote areas by reducing the need for either patients or specialists to travel in order to receive and/or provide healthcare to these areas [3]. Already a number of these types of telehealth services have been deployed. For example, Oliver et al. [4] has provided analogue videophone service to enhance palliative care in a remote area of South Australia. Lovell et al.[5] has also insisted that telehealth technologies as essential for managing chronic diseases based on their experiences from Australia and United Kingdom (UK). While broadband connected home-based telehealth applications and services like these appear to hold promise, the results of successful implementation are lacking. There is also rarely any insight offered into how technical feasibility interacts with meeting genuine patient needs in home-based environments or how usability of these devices ultimately supports a patient's ability to self-manage at home. This paper describes a telehealth platform called MediStation designed to support patients' in home-based environments. It confirms reliable home-based telehealth devices are technically feasible and usable by patients. The evaluation conducted on MediStation occurred in two parts: workshops with domain experts to evaluate the MediStation concept; and, assessment of the technical functionality of the device platform.

2 Background on Telehealth

In the last 10-15 years numerous telehealth devices, applications and services have been developed and deployed with major device manufacturers having already delivered a number of products to market. To this end, the push towards commercially available "retail devices" has been driven by Philips and IBM. In 2006, Philips began developing healthcare technologies: introduced "Motiva" to provide the TV-based healthcare service to older patients [6]. Currently, Philips is offering various types of patient care products [7], including anesthetic gas monitoring, blood pressure checkers and temperature checkers. Conversely, IBM[8] has developed a complete and integrated uHealth system that provides patients' medical record monitoring service. Beyond these "device-centric" developments by major manufacturers, there have been several "community based" systems developed. Oatfield Estates of Elite Care is a retirement village in the United States (US) and relies on telehealth for resident care [9]. Conversely, the South Korean government in providing the fastest

broadband network in the world has enabled researchers to consider more widely deployed telehealth monitoring systems beyond those typically localized to nursing homes or residential care situations. Many Korean companies have participated in the health care services development. Firstly, Samsung established the Ubiquitous city (U-city) [10], which provides telehealth devices, sensors, and remote monitoring for every facility in the city. One of the small and medium companies, GB-Tech, is one example of a Korean small-to-medium-enterprise (SME) that has introduced a eHealth device, called MediStation.

3 Methodology

This paper generates insights using an example telehealth platform, MediStation, to highlight the issues that continue to challenge the vision of telehealth and that are likely to directly impact on how well Australia can leverage the NBN to facilitate equitable improvements in healthcare delivery. Whereas previous work has specifically focused on developing systems, the approach taken here is to assess an example device with the intention of identifying challenges. Specifically, we evaluate the MediStation amongst a group of experts from different research domains.

The evaluation was carried out in two phases and these are briefly described. Phase one was a semi-structured workshop with a group of domain experts discussing the devices strengths, weaknesses, opportunities and threats (i.e. SWOT analysis) for the device. The domain experts were experts in different research fields: clinical, expert systems and smart services, and human centered systems design. The workshop involved the experts being asked “leading questions” in each SWOT category – the responses and subsequent questions which emerged in each category were recorded. Conversely, Phase Two was an assessment of the MediStation’s technology: software and hardware, focusing on technological capabilities and the technological context in which such a device would be operating.

4 Results and Discussion

The results of both Phase One and Phase Two are presented in this section. We have separated the results of both evaluation phases to differentiate between opinions of the domain experts and observations made around the technology itself.

Phase One: Evaluation of MediStation from domain experts’ point of view
The experts offered a range of feedback on the MediStation in the context that it is an example of the likely type of “retail” telehealth device to appear for use in the NBN. By far the largest point of discussion was the device’s ability to collect useful data for analysis from a patient. The user is required to: manipulate the touchscreen; instruct the device to open or close the biological sampling tray; provide samples and insert this into the tray; and instruct the device to send/receive sample analysis. The data collection process to the experts seemed to be a significant impediment to “easy use. Conversely, it was suggested that data collection should be largely automated in a

telehealth application. In the case of the MediStation, this would mean equipping it with different sensors than those already on the device. Specifically, sensors for "sleep monitoring" or "heart rate" could be worn by a user rather than having the user manually interact with the device to provide these samples. Devices to collect these samples exist and would simply need integration with the devices existing communications channels. Potentially this would counter the need for users to become familiar with the devices interfaces but would introduce potentialities around privacy: the extent of samples taken automatically without user consent was an emergent issue stemming from this discussion area. Moreover, the passive collection of data from such sensors could avoid potential for errors arising through misuse. When examining the MediStation, many in the group felt that samples collected through devices "biological sampling tray" could be easily contaminated because the tray is not of clinical standard. Because the device would be used in someone's home, without any supervision, it would be entirely possible that a previous sample would contaminate a new one, or contaminants could end up on the current sample through poor insertion or poor collection. To this end, passive collection would be useful in correlating active collection – passive data coming from a heart rate monitor worn by the user could be correlated with the active monitor installed in the device. During clinical experimentation, the challenge would become ensuring users did not "miss sampling days" and hence accuracy of a patient's health over time. Experience of experts through other projects has been most users stop using the device almost immediately after the experiment is over. Consequently, if the device was to "go live" the risk is with any unnecessary overhead difficult data input would only exacerbate the drive to stop using the device. A larger issue identified was the "value proposition" of the MediStation in the Australian context: the value of simply monitoring patients through sample collection and remote analysis was agreed the group as "not being a high value model". The value in telehealth seems to be in the information and knowledge derived from the data streams. Consequently, one suggested improvement was to use the MediStation in a telehealth situation as a "social tool" for facilitating the patient/doctor relationship. This means that rather than rely on the device for pure diagnostic information, data is used to support a "dialogue" between the patient and doctor undertake during normal consultation. Clearly, this is a different value proposition than to the one the device is marketed for and also not one that immediately takes advantage of an NBN. Conversely, one that does, as suggested by the group, is linking the MediStation to a remote "expert system" for automated analysis of the collected data. One technology familiar to the group of experts, Multiple Classification Ripple Down Rules (MCRDR), can diagnose clinical problems when it is supplied with values for a parameter set. In this case: MediStation would send its data to an MCRDR server; the server could provide a diagnosis based on the raw inputs; and then return a response to the user with any significant abnormalities reported immediately to a clinician. As the devices become ubiquitous, the telehealth applications information becomes its real strength.

Phase Two – Evaluation of MediStation from technological point of view

As a device which integrates modalities, the MediStation is an integrated system. These days developments in computing are rapid and consequently the most significant observation of the MediStation was around its integration of technologies

without possibility for upgrading them. Moreover, the device is heavily focused on internal capabilities rather than those, which could source from other more sophisticated/specialized/accurate devices. In general, the group felt that it would be important in any NBN-oriented telehealth application to take advantage of all available sensors in the environment rather than be limited to those in the device. The device may support some specific sensors, but it should be extensible to communicate with external devices. There are devices, which are seemingly ubiquitous in the marketplace such as the Smart Phone, and many of these devices have capability for supporting add-on hardware such as blood-glucose-monitors that can interface to them over Bluetooth. The advantage of the model used here is that as technologies change or improve, they can readily adapt to the Smart Phone. As a device which is supposed to operate in one's home, the MediStation's capabilities are relatively weak.

This approach would overcome another apparent deficiency in the design of a standalone telehealth device – "shared usage" by multiple patients of the device. In the case of the MediStation, many users located within a home are supposed to use it. However, the device itself has a number of limitations around this approach. Firstly, there is no surety around "clinical sanitization" of the sampling tray: one individual's samples could contaminate the tray. Secondly, the distinct "lack of security" on the existing software and hence the need to ensure any custom software stores and transmits data encrypted. In contrast, given the widespread individual ownership of smart phones in Australia, applications built around these devices, are associated generally with a single owner and therefore, there is limited no need to worry about shared usage. Conversely, one suggestion put forward in the group was the "virtualization of the concept of the MediStation." Telehealth as envisaged through a device such as the MediStation seems relatively limited given the shift in the way devices, these days, now interact. The vision of ubiquity presented by Weiser in which devices seemingly blend into the background is not realizable using this device. Recall, the burden on data collection this device has – conversely, by introducing passive sensors for data collection, enabling the device to connect to others to take advantage of their functionality, the device would become more functional.

In summary, it seems that there are a range of sociotechnical requirements, which emerge when experts with a range of expertise work collectively to assess the feasibility of a device in NBN context:

- data should be collected from the user automatically, thereby avoiding potential for sample contamination, minimization of effort for use, training, or patient input/output limitations;
- individual sensory data streams should be integrated to generate compound information streams and linked into a knowledge base leading to a high value model of telehealth;
- finally, the telehealth device should take advantage of the variety of sensors that might be deployed in the field already, thereby improving extensibility of the device and increasing its potential use in a wide variety of applications or contexts e.g. nursing home or general in-home use;

Many of the above outcomes of the evaluation process suggest devices developed and deployed for use on a broadband network for telehealth will need to be sensitive to the socio-technical challenges.

5 Conclusion

This paper has highlighted challenges for Australian telehealth if the potential of NBN is to be realized. Currently the predominately technocentric approaches embedded in existing telehealth devices/platforms like MediStation highlight the need for more research into how these devices will actually meet a sustained patient need. It does appear that in terms of telehealth at least the NBN is a solution looking for a problem and that more work is required before its potential use for increasing patient access to services and to improve their capacity to self-manage at home will be achieved. While broadband connected home-based telehealth does hold promise there is a need for more examples of successful implementation and knowledge into how technical feasibility of these systems interacts with meeting genuine patient needs in home-based environments. Similarly more work is required into how usability of these devices ultimately supports a patient's ability to self-manage at home. This paper has examined the MediStation device and confirmed reliable home-based telehealth devices are technically feasible and usable by patients.

Acknowledgement

This project was funded by Korea Small and Medium Business Administration

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