Integrated Health and Well Being – Smart Homes Technologies: taking care of the most vulnerable in society

Case Study: THE NHS WESTERN ISLES SAFE at HOME (WISH) PROJECT

Patients with health and care needs often remain in hospital longer than is clinically necessary because there is insufficient support for them to return to their own homes. Assistive technology has the potential to support these individuals, although there is limited evaluation of such systems in practice (Totten, et al., 2016). The WISH project aims to address this through the provision of remote monitoring of conditions via telehealth systems. This includes specific measures such as those aspects which can help monitor important health signs, for example, pulse rate, blood oxygen saturation levels and blood pressure. Wider factors, however, can also adversely affect the home living environment and the health and wellbeing of occupants (i.e. poor air quality, temperature, and humidity (Cincinelli & Martellini, 2017; Pitarma, et al., 2017; Rumchev, et al., 2007). Monitoring technologies can also provide greater insights into their individual states of being via their levels of activity. For instance, providing information on bed or chair occupancy, anomalous behaviors or routines, or alarming durations of inactivity.

In order to assist the NHS Western Isles conceptualize their desire to develop and implement an innovative and ground-breaking integrated health, wellbeing and care service to complement their existing telecare infrastructure, Caburn Solutions worked closely with them to deliver a prototype solution. Integrating a variety of health and smart home technologies for providing a testbed of these services.

The project successfully implemented a proof of concept within six homes. Validating the technical feasibility of remotely monitoring patients and those with more specific care needs. The patients and their families, as well as their care teams were actively involved to ensure that all stakeholders consented and were fully-informed and comfortable throughout the process, specifically, the aims of the project, the way the monitoring would be carried out, how any data would be used, methods of feedback and the success criteria. Academic input was provided by the University of Manchester School of Nursing.

The solution implemented offered monitoring without being dependent on the provision of home broadband. Data was collected locally using encrypted wireless short-range connections (Z-Wave and Bluetooth [BLE]) within the home to the home-smart-gateway. This data was then sent over the mobile GSM network. Making the installation simple and non-intrusive.

Key Lessons:

Feedback from a wide range of stakeholders, patients, relatives, and health and care professionals was gained. The perspectives of Nursing teams were captured by the University of Manchester though interactive workshops.

The key lessons were as follows:

i) Nursing teams felt that the technologies could be helpful as an alert system for those patients with neurological conditions.
ii) Nurses also felt that the technologies could also help with those having a relapse such as those with MS.
iii) The systems were thought to have most benefit for those in the most rural communities, as they were harder to reach or for those with mobility issues.
iv) It was felt that the system could be made more useful via the addition of LT EEG monitoring to measure Atrial Fibrillation. CO2 sensors could also help detect respiratory failure.
v) Given the lack of mobility of many patients, it was felt that the addition of a personal mobile pendant, with call or voice capability was important.
vi) Fall detection was viewed as being important, given the often catastrophic affects they can have on individuals, their health and wellbeing.
vii) Health professionals felt that the systems may help some individuals and families by reducing anxiety, particularly in difficult periods or the winter months where travel is more difficult.
viii) There was also the concern for nurse teams that for some patients, the technologies could increase anxiety. For some, having access to more detailed information and measurements could increase their levels of concern towards their health and wellbeing.
ix) It was felt that providing more information on the environment and the activity of the patient could help care teams make more informed decisions around visits.
x) There was a concern that such technologies could reduce patient visits, which might have a detrimental affect on patients. Personal touch and face to face visits remain an important part of health and care provision.
xi) There were concerns raised about whether health systems by becoming reliant on such technologies, could be potentially disrupted if there was any loss of service.
xii) There was a concern that the technologies, might be viewed by some patients as eroding their privacy and independence.
xiii) The information decision making was viewed as critical to the success of any service. It was a concern that false alarms could place greater strain on already stretched resources. For example, resulting in unnecessary ambulance callouts.

xiv) It was felt that provisions of services would need to be tailored to match the use of technology. For example, the ability to deal with incidents out of hours.

xv) There was a concern that the system would need to be flexible to allow normal and slightly out of routine, but normal behaviors to filtered and not result in unnecessary action which impacted on the lifestyle or wellbeing of the individual. For example, how would the system differentiate between a normal lie-in, or the patient being in bed due to a fall or illness?

xvi) Medical professionals would need to help design information dashboards. Information viewable by patients, clinicians and nurses would likely need to be tailored. The formation of logic and algorithms that resulted in visits or prioritizing care would need to be developed in conjunction with those teams.

xvii) The system would need to strike the right balance between providing simple dashboards and the ability to dig deeper into the information if needed, or desired.

xviii) To be successful, the implementation of such a system would need to complement and augment what carers and nurses already do. It must not impair or be viewed as a replacement for the important services they provide.

xix) The importance of batteries was raised as an issue. Many of the sensors used Lithium batteries, which in a remote location can be an issue, given restrictions on air transport. Management systems which provide early warnings are therefore extremely helpful in managing the operational logistics of these systems.

xx) Mobile technology coverage was good and proved a useful mechanism for transmission of data.

xxi) Overall, the system was perceived favorably, provided it was viewed as a tool for helping bring families together and helping strengthen relationships between clinicians, nurses and carers. Previous studies have found that the use of technologies in healthcare can improve correspondence and the quality of information between patients and their carers (Gagnon, et al., 2016; MacNeill, et al., 2014; Townsend, et al., 2015).

xxii) It was therefore felt that the technology was ‘right for the right people’ and should only in the future be referred based upon clinical need and consent.

xxiii) Any further implementation, however, would need further MHRA advice on the use of technologies in Medical Care. This is in reference to their recognition that digital technologies have a key role to play in future care provision and that regulations are needed that encompass the use of such technologies. They would also need to involve NICE and their digital health guidelines.

This test base proved invaluable for all the stakeholders in understanding the regulatory, technological, and human issues around integrating smart home technologies and telehealth service provision. Those lessons have formed part of the continuing developments for the stakeholders and partners involved in the NHS Western Isles WISH project.

About Caburn Solutions

Caburn Solutions are an innovative, and specialised Internet-of-Things (IoT) company with a background in health and environmental monitoring. Our focus being the development of ground-breaking managed home gateways and sensors which place occupant privacy, wellbeing, and security to the fore. Our innovative approach to home monitoring removes barriers between smart-home technologies, telehealth, and indoor environmental-monitoring. Where a range of different commercially available and highly specialised sensors are connected to a single gateway. Our secure cloud-based systems ingest data for visual presentation and analysis, while notifying stakeholders to act via simple messaging or instructions.

Caburn Solutions technical implementation is highly innovative as it uses prevalent smart-home technologies to interface with a local OEM gateway. The Caburn Solutions' gateway software is programmed onto a Java programming platform, providing gateway/sensor integration/management, and communications administration. The gateway uses low-overhead Mqtt IoT protocols to communicate over a multinetwork GSM modem and SIM card. This secure and encrypted transmission of data is then ingested from a Mqtt broker and stored using Microsoft Azure cloud systems. The data being presented via Caburn Solutions' own systems for dashboarding, charting and detailed historical analysis. They not only monitor data, but also the wide-area and local connectivity status of gateways and sensors, providing a visual/historical log of any downtime. The systems also provide alerts to warn of preventative/planned maintenance needs. For example, battery low warnings in sensors. The gateway utilises a low-voltage power-supply (5V), which includes an onboard battery to enable communication for up to 2-hours if power is lost. The systems also provide notifications to residents via web-portal-access, email and SMS; Providing recommendations for corrective actions for improving air-quality and reducing the level of pollutants. One instance being, measuring door and window opening/closing for managing air-ventilation.

Our monitoring solution is innovative and competes well as it is scalable and infrastructure independent; utilizing 3G/4G GSM licensed networks (having the benefit of also being able to use fixed broadband if required). The system uses well-established open smart-home encrypted wireless device protocols such as ZigBee (The Zigbee Alliance) and Bluetooth. One benefit of Zigbee being the formation of a mesh-network between sensors to extend ranges between devices in the home. The flexibility of our IoT gateway technology means connecting new sensors via software downloads in the future is simple. Our other sensors (or new ones as they become available) can be easily added.

The Intellectual Property of Caburn Solutions' system resides in; i) the Java based gateway software; ii) the Mqtt broker and subscriber interface; iii) the gateway and sensor management platform; iv) the connectivity management platform; and v) the data management platform. There is significant software development invested in the gateway, sensor data ingestion, storage, management platforms, and the data presentation/notification systems. Involving; a) the aggregation of multiple sources of sensor and gateway data into a logical, organised and manageable structure; b) the storage of information; c) the selective presentation of data and management information into easy to understand web interfaces; d) the availability of live and historical histogram charts for any device and any measured parameter; e) the flexible configuration of sensors, gateways, and intervention parameters for creating alerts; f) the ability to allocate contacts for incident management for automatically communicating problems by email or SMS to appropriate stakeholders; g) the ability to audit connectivity for both the links between sensors and gateways, as well as between the gateways and the cloud/server systems (and if necessary create alarms); h) the ability to create warnings for operational maintenance events (such as sensors or gateways being off-line, or sending low battery warnings).

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References

Cincinelli, A. & Martellini, T., 2017. Indoor air quality and health.

Gagnon, M., Ngangue, P., Payne-Gagnon, J. & Desmartis, M., 2016. mHealth adoption by healthcare professionals: a systematic review.. *Journal of the American Medical Informatics Association,* 23(1), pp. 212-220.

Kelly, F. & Fussell, J., 2019. Improving indoor air quality, health and performance within environments where people live, travel, learn and work.. *Atmospheric environment,* Volume 200, pp. 90-109.

MacNeill, V. et al., 2014. Experiences of front-line health professionals in the delivery of telehealth: a qualitative study.. *British Journal of General Practice,* 64(624), pp. e401-e407.

Pitarma, R., Marques, G. & Ferreira, B., 2017. Monitoring indoor air quality for enhanced occupational health. *Journal of medical systems,* 41(2), p. 23.

Rumchev, K., Brown, H. & Spickett, J., 2007. Volatile organic compounds: do they present a risk to our health?. *Reviews on environmental health,* 22(1), pp. 67-82.

Totten, A. et al., 2016. Telehealth: Mapping the Evidence for Patient Outcomes From Systematic Reviews. *Technical Briefs,* Volume 26.

Townsend, A. et al., 2015. eHealth, Participatory Meidcine, and Ethical Care: A Focus Group Study of Patients' and Health Care Providers' Use of Health-Related Internet Information.. *Journal of Medical Internet Research,* 17(6), p. e155.