Telehealth monitoring of a hypertensive elderly patient with the new VITASENIOR-MT system – a case study

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Abstract

Telehealth technologies providing remote monitoring of health parameters are a promising approach for the management of arterial hypertension (AH) in the elderly. The VITASENIOR-MT platform was developed as a telehealth solution designed to contribute to improve the health condition and quality of life, promoting safe and independent living of the old adult. It is an 'internet-of-things'-based solution relying on the interaction of the old adult with a TV-set to record biometric parameters and to receive warning and recommendations related to health and environmental sensor recordings. We present a pilot study with a male hypertensive patient, aged 81 years old, under anti-hypertensive treatment, with epilepsy, arthritis and paroxistic atrial fibrillation as major comorbidities. The VITASENIOR-MT was installed at the patient′s assisted-dwelling house and a remote follow-up was implemented during 2 months, monitoring daily blood pressure and heart rate, as well as weight and indoor environmental parameters.

Keywords: Ageing; Hypertension; Telehealth; Remote monitoring

Introduction

Demographic ageing is currently acknowledged as a major societal challenge.[1] Most of the elderly suffer from chronic health conditions, which are associated with significant morbidity and mortality.[2] Arterial hypertension (AH) is particularly prevalent in this population [3] and contributes heavily to the burden of major cardiovascular events in the elderly [4]. The management of AH in the elderly patient is particularly complex, given the multimorbidity [2] that is commonly found aside with complex polimedications regimens. [5] Additionally, health literacy is limited in this population, either due to low scholarity, trouble in accessing relevant health-related information, or little access to medical care.[6] Furthermore, social isolation is common in old adults, leading to depression and social exclusion, and about 24.4% of the old adults live alone and 58.3% live with only one person.[7,8]

Considering the need to tackle the challenges identified at the individual level in the hypertensive elderly population, several technological solutions have been developed to avoid the institutionalization, promote independent living, provide safety and security, and ensure health and environmental monitoring.[9,10] The benefits of incorporating telehealth solutions to promote active ageing and independent living of the old adult have been thoroughly studied and discussed. Several meta-analysis have compiled evidence in quite diverse subsets of the elderly population, finding consistent benefits for different technological resources. [e.g. 11] The VITASENIOR-MT telehealth solution was developed as a technological solution amenable to tailored configurations meeting the individual needs, allowing for the clinical monitoring of chronic conditions in the elderly populations, as well as ambient monitoring adding another layer of safety and confidence to the old adult living independently. [12]. This report depicts the application of this technology in the follow-up and clinical management of a hypertensive old adult.

Methods

Global architecture of the VITASENIOR-MT system

VITASENIOR-MT is a home healthcare platform that was designed as an IoT architecture for remote monitoring of biometric and environmental data. The hardware and software architectures of the platform were previously described in [12] and [13]. The system comprises four sub-systems: a home-care platform based on a TV set for interaction with direct end-users, a wireless sensor network (WSN) for environmental data collection, a cloud infrastructure following a microservice and fog-computing architecture, and a web portal for interaction with formal and informal caregivers.

The platform was developed following a human-centred design approach, involving seniors and health professionals at different stages of the project. The main development focus was on the platform usability, particularly, on the interaction of the seniors with medical devices, meeting their specific needs and skills. To avoid devices that older people are often unable to use, such as smartphones, tablets and computers, due to visual, hearing, motor or mental disabilities, user interaction with the home care platform is via a TV set and a Remote Control. These devices are very familiar to the elderly population and eliminate the barriers associated with learning new digital technologies. Using only 7 keys of the TV remote, users can transparently access multiple Bluetooth medical devices, namely, blood-pressure meter, glucometer, oximeter and weight scale (heart-rate is included in the blood-pressure meter and the oximeter). To access a given medical device, the user just needs to select the device associated to his profile, and press the ‘OK’ key. Each medical device has its own way of operation. For example, a blood-pressure measurement requires pressing the start button, whereas, for the weight scale the user only needs to step on the scale. The collected data are transparently sent to the Cloud and made available to health professionals and formal/informal caregivers through a web portal. Doctors set clinical profiles and schedule the frequency of exams. If abnormal values are detected, a notification is generated appearing on the main page of the web portal. Whenever a senior does not take an exam as scheduled, a notification is sent to the TV as a reminder. It is important to note that the TV set is the same one used to watch TV broadcast, and these reminders appear blinking on the lower right corner of the screen. By pressing the ‘OK’ key, the system switches to the healthcare mode and the full notification can be read. To manually toggle between the two modes, healthcare and broadcast TV, the user only has to press the ‘1’ key. Alarm situations related to abnormal environmental measurements (CO, CO2, temperature and humidity) automatically trigger

the TV to switch to an alarm screen accompanied by an audible warning.

Case study

A male community dwelling hypertensive old adult (Patient A), aged 81 years old, body mass index 25.18 Kg/m^2, non-smoker, low literacy, and no history of previous major cardiovascular events, volunteered to participate in a pilot study addressing the usefulness of the VITASENIOR-MT system in the follow-up of hypertensive old adults. The patient lives autonomously with his wife at his assisted-dwelling house. The patient is under anti-hypertensive treatment with an association of a calcium channel blocker and an angiotensin-converting enzyme inhibitor for more than two decades, with apparently good blood pressure control. Comorbidities included epilepsy, arthritis and paroxistic atrial fibrillation, contributing to a complex context of polimedications. The system was assembled at the home of Patient A, and all the necessary sensors were provided, as well as an on-site tutorial regarding the handling of all the system components. Sensors for measuring blood pressure and heart rate and a scale for weight control were provided. An oscilometric research grade automated sphygmomanometer (Mysignals, Libelium Comunicaciones Distribuidas S.L.) with Bluetooth communication with the VITASENIOR-MT platform was used in this preliminary evaluation of the system performance. A preliminary comparison of this device against a grade A sphygmomanometer was implemented in persons with diverse clinical profiles to ensure the validity of the BP measurements. The use of this research monitor was instrumental to the development phase of communication protocols which will allow for the integration of commercially available and clinically validated automated sphygmomanometers. Also, environmental sensors were placed at home for monitoring carbon dioxide (CO2) an carbon monoxide (CO) levels and inner temperature and humidity.

A clinical profile was created in the VITASENIOR-MT platform allowing for the clinical management and follow-up of Patient A based on telehealth. A protocol of blood pressure measurement was defined: two measurements in the morning (around 10 o'clock) and two measurement in the afternoon (around 16 o'clock), everyday for two months. Warnings were programmed to remind the patient to measure blood pressure according to the protocol, therefore there were no missing readings during the follow-up period. Patient A was instructed to measure weight daily.

Figure 1. Screenshots of the data contained in the VITASENIOR-MP platform for patient A. Panel 1 depicts a summary of the clinical profile and the trend for weight variation. Panel 2 represents the variation in systolic and diastolic blood pressure (respectively, SBP and DBP), and in heart rate variation. Panel 3 represents changes in carbon monoxide over time.

Figure 1 depicts a summary of the information retrieve during the two-months follow-up period. In panel 1, the trend revealed a consistent gain in weight, for which lifestyle recommendations were provided aimed at controlling the weight-gain increase, mainly through nutritional caloric restriction and activity promotion. As for blood pressure, represented in panel 2 of figure 1, a stable profile for SBP was observed as well as for DBP, translating a good overall blood pressure control. Mean SBP was 117.3±7.0 mmHg, and mean DBP was 75.9±8.5 mmHg for the entire recording period. Heart rate was 75.9±8.5 bpm on average. Visit-to-visit BP variation was also estimated as the absolute difference in consecutive measurements. The mean absolute difference was 7.3±6.2 for SBP and 9.0±8.1 for DBP, corresponding to a coefficient of variation of 6.2 and 11.9, respectively, therefore the patient presented a good BP variability profile. Notwithstanding, occasional increases in DBP were observed (highest: 102 mmHg) which motivated a close monitoring of blood pressure profile over time, with no need for therapeutic readjustments. Occasional events of elevated heart rate were also observed, probably related with episodes of paroxistic atrial fibrillation, entailing the need to incorporate wearable ECG monitors to the platform as a technological development to pursue. Environmental screening was also a valuable tool to monitor living conditions and good temperature, humidity and CO2 indoor levels were observed during the follow-up period. Panel 3 of figure 1 depicts the changes in CO2 over time.

Discussion

Telehealth solutions are promising tools to tackle the challenges of demographic ageing and are particularly useful for monitoring the health status of the old adult. Considering AH, several studies provided evidence in favour of integrating these technological resources into the clinical management of patients. [10,11] The pilot data obtained with the VITASENIOR-MT platform provides promising features, providing continuous monitorization of blood pressure and other relevant physiological and environmental parameters, allowing for interaction between the user and the care provider, and offering tailored configurations meeting the individual need with an user-centred architecture. The possibility of operating the system in a friendly and intuitive environment, using the TV remote control, makes it independent of the technological literacy of the old adults, which

is a foremost advantage in comparison with other available solutions. The simultaneous monitorization of physiological and environmental data by carers and health professionals also offers additional layers of safety for the promotion of autonomous and independent living of the old adult. The possibility of tailoring the system to the individual needs is also a differentiating aspect of the platform, and the inclusion of remote videoconference clinical assessments is currently being developed. The major challenge for this type of technological solution is the resistance to change by some old adults, and the need to maintain motivation along the learning curve that it encompasses.

Therefore, this telehealth solution could significantly contribute to improve health outcomes in older adults, and could be a relevant practical tool to overcome barriers of distance and access to care and to provide clinical vigilance to hypertensive old adults. The usefulness of such technological solutions have been acknowledged and encouraged by several international medical societies, such as the European Society of Hypertension.[14] Long-term studies with the implementation of the VITASENIOR-MT platform in a large subset of patients will provide evidence regarding the effectiveness and usability of the platform. Currently, the VITASENIOR-MT platform is being considered to integrate the certified Home Hospitalization Unit of the Centro Hospitalar do Médio Tejo (Portugal). At the same time, plans are underway with the Intermunicipal Community of Medio Tejo (CIMT) to expand the number of homes monitored to complement their home visits to elderly people living alone. These two measures will certainly contribute to a better assessment of the impact of this technology in a larger population.

Disclosure

I declare that there are no pertinent conflict.

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