Conceptualization of WECARE: A Community-based Platform for Minimizing Consequences of Fall in Elderly People

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Abstract: The number of aged population is growing consistently, and is expected to triple by few next decades. One of the most threatening risk aged population have to face in their daily life is falling. Falling can pose serious injuries and consequences to elderly people, especially when they live alone or have cognitive dysfunction. If the elderly lives alone when an accident happens, it is more likely to take a long time until someone notices and provides rescue. Moreover, if the elderly has cognitive disorder such as Alzheimer's disease, it is possible that he or she will not try to seek help. In this paper, an online platform called WECARE is proposed. WECARE aims to minimize the consequence of delayed rescue after a fall accident. The main advantage of the platform is the integration of community volunteers into the already widespread technologies such as fall detection systems and automatic doors. The benefits of volunteers could be a faster response after a fall accident and social connection provided to elderly people, especially the ones who live alone. This paper also describes how the idea was originated, modified, and improved through methodology. It also discusses advantages of the platform, limitations, as well as its future.

1 INTRODUCTION

In the world, the proportion of elderly people is increasing in almost every country. The number of people aged 65 or above was 615 million in 2017, and expected to rise to 1,6 billion in 2050 (Wan et al., 2016). The world is transforming into an aging society. In France, the percentage of elderly age 65 or above is 18,8% of the total population, which means 12.5 million people in total (Eurostat, 2016). Many of the elderly people want to remain autonomous and to stay independent as long as possible. In comparison to retirement homes, they prefer to stay at home (Boland et al., 2017). However, by staying at home, elderly are exposed to the risk of facing an accident without receiving help. And one of the said accident is fall. Fall is very common, 30% of the elderly fall each year, and up to 10% of the falls can lead to severe consequences like head injury and bone fracture (Silvia et al., 2010).

A factor contributing greatly to the severity of fall in elderly people is the time that elderly spend on the floor after the fall. Indeed, some of the elderly will not be able to get up without help and therefore spend long time lying on the floor. When elderly fall and spend time on the floor for more than one hour, they can develop rhabdomyolysis, pressure sore, and dehydration (Mallison and Green, 1985; Tinetti et al., 1993). Other than physical injuries, fall can cause psychomotor disadaptation syndrome, and posttraumatic stress disorder (Eric et al., 2010). Also, when elderly fall and spent a long time on the floor, they are five times more likely to die within six to twelve months in comparison to the elderly in the same age and gender group who did not experience a fall (Wild et al., 1981). Falls are caused by

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multifactorial parameters in older adults, with dementia increasing the number of falls significantly (Fernando et al., 2017; Petersen et al, 2018). Moreover, cognitive impairment is a factor that contributes to both prevalence of falls and inability to get up after falls (Jane and Carol, 2008).

The first data provided by the exploration of seniors' perceptions of the behavioural factors associated with falls (Robson et al., 2018) shows the importance of maintaining elderly's independence despite the risk of falling. Unfortunately, for reasons of safety, instead of giving them home-care, relatives may decide to admit elderly people to retirement homes (Lord et al., 2016). Cognitive impairment could be a reason given by families to do so despite the patient's willingness to stay at home (Lord et al., 2015). Thus, promoting home care for the elderly leads to the question of fall management, from detection to care.

Out of 12,5 million elderly which live in France, 37,5% of them live alone (Eurostat, 2015). Living alone not only makes them prone to lie on the floor for a long time without anyone noticing but also subjects them in their daily routine to the possibility of social isolation. Many research has shown that social isolation and loneliness can have negatives effect on health and wellbeing of people (Hanbyul et al., 2015; John et al., 2011; Tomaka et al., 2006). On the contrary, social activities and human interaction can promote good health and preserve cognitive function (Glei et al., 2005; Joe et al., 2003). In this context, caregivers involvement, both formal and informal, can be a way to provide elderly people with care and social interactions.

Therefore, it would benefit the society and seniors greatly, especially those with dementia, if we could provide them a fall detection environment offering fast rescue, respecting their privacy and preventing the negative effects of social isolation by giving them the social context.

2 TECHNOLOGICAL CONTEXTS

At present, there is no system which represents as the gold standard for minimizing consequences of fall. To address the fall problems, one topic that is widely researched and developed is the use of fall detection systems which can be generally represented as shown in Figure 1. In the market, there are various companies that offer active fall detection systems which require interactions from users. The active devices are usually presented as a wearable devices such as wrist watches or pendants incorporate with a trigger button that is pushed by users in case of fall accident (Muhammad and Ling, 2013). However, the situation is more complex for elderly with dementia, because they can easily forget to wear or how to operate the device (Koldo et al., 2017).

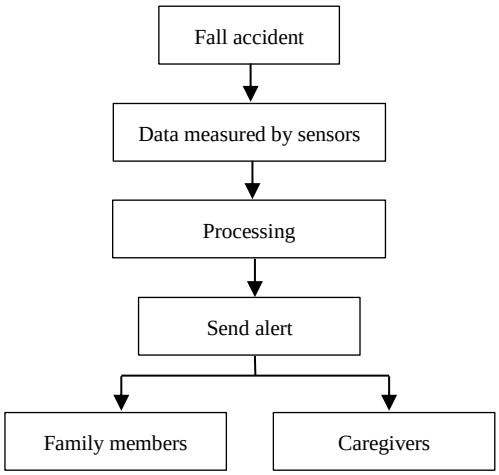

Figure 1: General representation of a fall detection system.

Another approach is a passive system which can be classified by the type of sensor, such as cameras, kinect cameras, floor-embeded sensors, or microphone arrays (Natthapon, 2014). The passive fall detection system can be a more logical solution for elderly people with dementia due to the fact that it requires no interactions from the users both in cases of normal usage and in events of fall. However, some of the solutions are considered as too privacy-intrusive, especially the cameras or microphones based solutions (Brownsell and Hawley, 2004). Therefore, the privacy of elderly, acceptability of the devices and how the elderly with dementia react to the technologies are important factors that need to be considered.

Following the advancement of information technology in health care, the involvement of non-professional in out-of-hospital care services is increasing (Elina, 2017). Although not in the context of fall, there have been several projects that successfully integrating volunteers into the system. They are mobile-based alert systems for out-of-hospital cardiac arrest. Non-professional personnel, including laypersons and trained-volunteers, will be notified and dispatched to act as a fast respondent in cases of cardiac arrest. These systems showed promising results in increasing survival rate of the cardiac arrest victims and reducing the responding time lag following the incident (Mattias et al., 2015; Pijls et al, 2016; Christopher et al., 2017).

In this paper, the development of a platform called WECARE is presented. It was initiated during a summer school event promoted by EIT Health (European Institute of Innovation & Technology for Health) which is a European health innovators network. The proposed solution is a platform which integrated volunteer networks and a mobile phone application that can connect with specified fall detection systems and automatic doors installed in the house of elderly people.

3 METHODOLOGY

The concept of WECARE platform originated from a multidisciplinary team composed of a medical student, a healthcare business analyst, a healthcare technologist and biomedical engineers. With the help of open innovation events as well as specific project management, the concept was developed through means and methods described as follow.

3.1 ClinMed

ClinMed2018 was a summer school organized by clinical investigation center in innovative technologies (CIC-IT) national network and held in France (ClinMed, 2018). It was the first ClinMed summer school with the objective of providing participants with perspective of how to develop an idea in the field of innovative technologies for health, from initial concept until reaching the market.

The summer school was organized into two phases. The first phase allowed the participants to experience and perceive the problems from an actual perspective. The second phase focused on incubating and developing the idea into a concrete concept.

In the first phase, the team was given a subject by geriatricians, aiming to minimize the severity of fall in elderly people suffering from dementia and living alone. To understand more the issues and needs related to the ageing society and the loss of autonomy, the team spent three days of immersive experience in the geriatric department of university hospital of Besançon, France, and with methodological supports from CIC INSERM 1431. Several meetings were conducted in order to gather requirements and needs from every stakeholders including healthcare providers, medical doctors, patients, and their family members.

Visiting of geriatric care units and retirement homes, along with explanations and inputs from geriatrician provided great benefits to the first conceptualization of a solution. Moreover, to understand what ageing is, the team experienced the aging simulation arranged by the geriatric department. The experiences consisted of several activities performed while wearing handicapped-equipment such as weighted outfits and blinded goggles. This kind of simulation aimed to make participants realize and understand the feeling of aged body and associated impairments.

During requirement gathering, the preservation of autonomy and security of people with dementia came out as the main needs. Although there are a lot of technological solutions for fall accident, privacy invasion and cognitive dysfunction of people with dementia are major obstacles for dissemination. A suitable solution needs then to find an agreeable balance between security and privacy of users.

The approach of brainstorming was used in order to find the suitable solution for the problem. Every possible ideas were proposed by team members. The second step consisted in selecting the most suitable ideas that the entire member agreed on. Although the issue of security-privacy balanced was not clearly settled, the first idea of solution was then proposed. Thus, originated the idea of a system that aim to minimize the lag time between fall accident and rescue attempt, and it is called WECARE.

The second phase of ClinMed2018 was a seven-day incubation process to develop further the first solution into a concrete and tangible concept. Under lessons, guidance and advices from experts in various fields, the first idea of WECARE was improved. The improvement of the concept was then done with the help of a team of mentors composed of clinicians, regulatory affairs specialists, experts in quality management system of medical devices, business analyst, and clinical research specialists.

After the second phase of ClinMed2018, the problem of balance between privacy and security was addressed. With the summer school event, the various aspects of WECARE along the life cycle of the product were considered and the concept of the solution was designed. Thus the next step was to develop a first prototype.

3.2 Hacking Health Besançon

Hacking Health is an event organized in order to bring together all the stakeholders in healthcare domain to tackle the problem of healthcare (Hacking Health Besançon, 2018). With various key players, this event can provide funding opportunities, resources, and help incubating ideas for new healthcare innovation especially for projects owned by an independent party (Walker et al., 2016).

To go on with the design and development of a first prototype of WECARE, a team of software developer was required. As the initial team did not possess the skill required, an event like Hacking Health Besançon presented a great opportunity. During the event, a team was formed, composed of people from the initial team WECARE and a group of back-end and front-end developers. After two days in the event, the main principle of WECARE platform was defined, the system was designed and an early prototype was developed in the form of a mobile application. The aim was to demonstrate the function of WECARE platform and to further facilitate the development. WECARE was awarded by juries with the "Best patient-centric solution" prize given by the representative of patient association. This led to the possible cooperation of targeted patients in the development processes so that the product will be well received by the end-users.

3.3 Preparation for Calls

Following Hacking Health, a larger team was formed. It included members from research and evaluation center, biomedical and computer engineers from engineering schools, and patient representatives.

After that, a new and more detailed development plan was structured in order to allow the preparation for the calls from EIT Health and French national research agency which can potentially provide the project with necessary funding and partnerships. The development plan is briefly explained in the subsection §6.4.

4 RESULT

After the conceptualization steps, WECARE was defined as a platform that connects with ambient fall detection systems and automatic doors installed in the user's house. The aim of the platform is to integrate all the people including healthcare providers, volunteers in the community, family members and senior peoples themselves into the system, and to facilitate a fast rescue in case of fall accidents. When there is a fall, WECARE will inform the elderly's family and the nearest available volunteers to the patient so that they can provide a fast intervention with the help of geo-localization and automatic home accessed permission. Moreover, by integrating volunteers and involved parties, the system also aims to provide social connections and all the linked benefit to both seniors and community around them.

The concept of the platform is represented as a map in Figure 2.

Figure 2: Concept map of WECARE.

4.1 Main Working Principle

When a fall accident happens, WECARE application will get a trigger signal from ambient fall detection sensors installed at the user's residence. The application will then send a notification to family members of the elderly.

After receiving the notification, the family members will decide if they can go to see their elder or not. If not, the notification will be forwarded to the nearest volunteer or nearby hospital depending on the availability of volunteers. The rescuer will receive information about the address location in the form of GPS map.

The rescuer will be able to enter the house with the automatic door and provide help if possible. In case of volunteer involvement, WECARE application will allow him to communicate with patient's family and nearby hospitals staff. The working principle of WECARE is shown in Figure 3.

4.2 Volunteers

WECARE platform will be used by volunteers who want to be the rescuer for elderly people in case of fall accident. The first step to become a volunteer is to create an account by filling all the information and upload all identification documents requested by the system. Once the requested document and information are properly validated and confirmed, he will get the confirmation email of successful registration; he/she could be asked to provide the missing information or document.

Once the registration is confirmed, the volunteer will have access to an online training of WECARE platform. The training will include recommendations for system usage as well as guidelines of patients rescuing procedure. After the training, there will be a meeting between seniors, family members, volunteers and healthcare providers. This will initiate and strengthen the connection between people and community. Finally, after confirmation and consent from the elderly and family members, the volunteer will be included in WECARE platform.

WECARE considers the social aspect representing by the volunteers' involvement as its main advantage. The platform not only focused on technology but also creating link between generations and improving safety for seniors in the community. Even in cases of false alarm which is currently a problem for fall detection systems, with volunteers involved, it can be turned into an opportunity to connect elderly people with the volunteers to prevent social isolation.

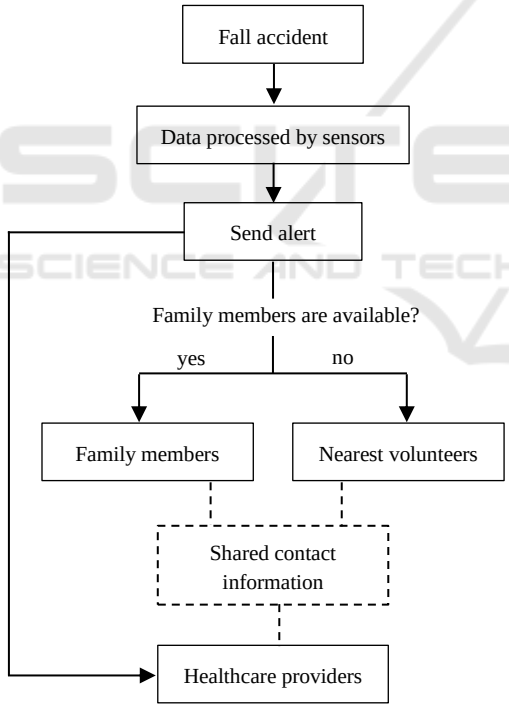

Figure 3: Working principle of WECARE.

4.3 Security-privacy Balance

The platform aims to provide security for elderly people while respecting their privacy. The most important part is that volunteers should be someone that elderly people and their family members trust. Therefore, to mitigate this problem, family members will have options to predetermine the preferred volunteers or avoid unwanted ones. In this way, the platform facilitates the acceptance and respect the consent of the users.

5 DISCUSSION

In conceptualization steps, WECARE is a platform that can provide numerous great benefits to both elderly people and the community around them. It aims to be a central piece by connecting already existing fall detection technologies and automatic door systems to facilitate a fast rescue. By integrating community volunteers into the technological solutions, the platform will be able to minimize the time patients spend on the floor after fall accidents. It also has a potential to provide social context and prevent isolation for elderly people who live alone. However, WECARE is not without its limitations.

The upcoming challenge of the system will be compatibility of the platform with the already existing technologies, both fall detection sensors and automatic doors. The implementation of the whole system to the already existing buildings could be difficult and possibly expensive. The management of signal that originate from various type of fall detection sensors will be a crucial step that needed to be considered.

The main advantage of WECARE relies on the social aspect, however the idea of letting someone who is not a family member into the house of elderly people is a bit ambitious, unless that such a volunteer is a trusted person like caregiver and healthcare provider. The creation and management of the volunteer network will be a challenging part of the project as well as how to make the system more acceptable for users. By continuous questioning and evaluation of the solution in terms of how sufficient (number and quality) is the network, will without a doubt lead to its improvement along all the life cycle of the project.

6 FUTURE WORKS

The next steps of the work will focus on the connectivity of the platform to the rest of the systems including fall detection sensors and automatic doors. Other issues that will need to be developed are the ethical aspect as well as usability and acceptability of the solution, and finally, to develop the volunteer network.

6.1 Fall Detection Sensors

WECARE aims to connect with ambient fall detection sensors which are sensors that are directly installed in the environment of the users. Due to cognitive dysfunctions of dementia patients, wearable devices are ill suited because the interactions with the device can be perceived as too complex. Therefore, it raises the issue of integration to WECARE. Another requirement for the sensors is that they should not be perceived by users as invasion of their privacy, such as camera-based sensors.

6.2 Automatic Door Systems

It is important to consider the type of automatic doors to be used depending on the location where they are going to be installed. A private location such as single house will pose little to no problem for the installation. However, if the location is an apartment or shared residence, the problem could become much more complex due to the possibility of having more than one-layer access such as a common door before entering the apartment. Other solution apart from the doors, such as key-containing boxes, should be considered.

Specifications of WECARE system will then take into account the existing possibilities for both fall detectors and automatic doors, in order to select the most relevant ones and manage communications with the more efficient technologies.

6.3 Ethics and Acceptability

Other essential aspects are ethics, acceptability, and usability of the solution. During the successive development phases of WECARE, surveys, tests, and evaluations should be done to further improve the concept of the system. The usability, acceptability and ethical aspect of the platform should be evaluated. Moreover, as some users of WECARE can consist of dementia patients, more investigations into concerned laws and regulations will be needed. Further explorations will evaluate usability and acceptability of the platform as perceived by all the users. Finally, specific evaluations will permit the quantification of the security, clinical efficiency and possible economic impacts of the solution.

6.4 Development Plan

As a result of various events, consultations with experts, and continuous reformation of the project, the next steps of WECARE were planned as follow.

6.4.1 Literature Review

A systematic literature review and an analysis of state-of-the-art are essential for the early stage of the project. Following PRISMA guidelines (Moher et al., 2015), the reviews will provide insights on the existing technologies and present the opportunities to identify advantages and disadvantages of other similar community-based projects. The important aspect of community-based system is the sustainability of both end-users and volunteers.

6.4.2 System Development

Planification and development of the minimum viable product (MVP) should be considered after the literature review. MVP, a system with just enough functions and features to answer the needs of users, is needed in order to facilitate and conduct the necessary studies which including feasibility and acceptability studies. MVP should be a functional product which included every possible parts of the full system including server, application, website, and database.

6.4.3 Studies

The involvement of end-users in all of development processes is very crucial, especially in the feasibility study. To test the feasibility of the system in the first phase of the study, the targeted populations can be elderly people without dementia and people from their community. Then, in the second phase of the study, the targeted populations will be elderly people with dementia, their family, and volunteers. The project will be assessed and redesigned with cooperation of this user group.

6.4.4 Economics

The economic aspects of the project will be taken into account in parallel with feasibility studies. Business model, operating costs, and reimbursement plan of the product will be elaborated in order to ensure not only the economic feasibility of the product but also to ensure the sustainability in the long run.

7 CONCLUSION

For aged population, the severity of fall accident depends not only on the impact force of the fall, but also on the time patients spend on the floor without rescue. The more time spending on the floor, the more complicated the treatment will be.

Through open innovation events and strong methodology, WECARE project and solution was conceptualized. ClinMed2018 summer school initiated the designation of the first concept while Hacking Health Besançon allowed the development of the first prototype. This resulted in the definition of a team with multiple skills, including a representative of end-users. This made it possible to draw up a detailed development plan, including feasibility studies.

WECARE intends to be a platform which aims to reduce the time patient spend on the floor by introducing the connection of fall detection sensors with automatic door systems to facilitate an easy rescue operation. In addition, the integration of volunteers into already existing technologies and rescue procedures can shorten the lag-time between the accident and the first intervention. It can also provide social benefits for elderly people even in case of a false alarm of falls while respecting ethical issue.

This paper proposed the first conceptualization of the WECARE platform and issues that need to be addressed before progressing into the next steps of development. Especially the challenges of legal considerations regarding the consent of the elderly people with dementia to use the platform, as well as the approach to implement protection necessary for this group of users. Evaluations will also take an important part in the developments. Such reflexions and integration of technologies can bring benefits and care to our aging population.

Finally, this paper proposed also a methodology for conceptualization of a project. Through the example of WECARE, each step of how the project was originated and improved were explained in the hope that this paper can help facilitate the genesis of relevant innovations in the field of healthcare.

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