

Innovative Project For Domomedicine Deployment

The PiCADO Pilot Project

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Abstract— PiCADO is a pilot project of domomedicine. Domomedicine has been defined by the French Academy of Technologies as "all procedures and care, sometimes complex, given at the patient's home or in his social and professional activities, [...] based on modern technologies. It aims at facilitating home support and promoting medical progress". Domomedicine can be seen as a system coordinating eHealth, telemedicine and social medicine. Through the PiCADO platform -a multi-user and multi-pathology technological platform- the PiCADO project will allow home monitoring of patients with cancer or cognitive impairment with loss of autonomy, based on the latest medical and scientific advances highlighting the importance of biological rhythms in the development of such diseases. As a work in progress, the technological platform has been developed through a collaborative methodology.

Keywords - Domomedicine; Circadian System; Biological Rhythms; Cancer; Cognitive Disorders with Loss of Autonomy; chronic diseases.

I. INTRODUCTION

The development of information and communication technologies and their large distribution in the population allows considering drastic changes in our health care systems. Widespread Internet access and daily use of mobile phones or tablets by users of all ages, from all socio-professional categories, of any culture, and any region, makes it possible to access medical information and health applications, leading people to contribute more actively to decisions regarding their own health. This societal trend of "connected health" allows more patients to avoid hospitalization. Medical care at home ensures safety and quality of care at least equivalent to conventional care.

In the same time, our health care systems must evolve as a result of demographic and socio-economic constraints. Indeed, incidence of chronic diseases is growing steadily, and this is partly related to life expectancy's extension. The average life expectancy has been increasing three months per year since 1950 in France, where expected years of life once at the age of 65 are 23.2 years for females and 18.7 years for

men. In France, at least one chronic disease affects more than 60% of people aged over 65 years [1]. Chronic diseases disrupt patients' quality of life and impact the national health expenditures. Most chronic diseases need long-term medical care and, sometimes, complex care. In France, long term diseases affected 8,000,000 patients in 2004, and four groups of diseases alone account for almost 80% of long term diseases: cardiovascular disease, cancer, diabetes and psychiatric disorders [2]. The increasing incidence of chronic diseases, co-morbidities, as well as the length and complexity of their medical, therapeutic and social support, have created a necessity to develop solutions that enable patients and / or elderly people to maintain their autonomy, to preserve a good quality of life, in order to prevent further health deterioration. The reactive nature of the current medical care organization does not appear to be adapted to the complex dynamics of chronic diseases, nor to their frequent associations, and their long lasting courses.

Healthcare stakeholders in France consider that necessary technologies to an evolution towards a home patient-centered health care system are now available. However, their usages remain fragmented, dedicated to a single disease or a single purpose [3]. Hundreds of experiments have been carried out without creating the conditions for the spread of methods and results, because of a lack of perspective of evolution towards an integrated system of health. However, a number of these experiments are considered as real success from the perspective of patients and caregivers. In this context, various French institutions like the Academy of Technologies and the High Authority for Health under the leadership of the General Direction of Care Offer analyzed the reasons of this limited development. The Academy of Technologies has highlighted the need for an integrated solution that considers the overall care of the patient at home, and, if necessary, hospitalization, without pathology segmentation. The Academy has pointed out problems of systems' redundancy, limitations due to a limited range of devices on the market, and difficulties encountered in these experiments to get integrated into the regional health information systems.

Hence, to deal with the increasing burden of chronic diseases challenging current European healthcare systems on the one hand, and to help facilitating the deployment of advanced technological solutions, the French Academy of Technologies has proposed domomedicine as a new integrated patient-centered model of care, adapted for multi-user, multi-pathologies, hence co-morbidities. The goal is to group acts and care in patient's home or in his social and professional activities. Those acts should be comparable in quantity and quality to those made in the hospital, and supported by information and communication systems and services [4][5]. This should allow maintaining patients at home or in their socio-professional activities with equal or better quality of care, while promoting medical progress. Indeed, the ultimate purpose of domomedicine is to bring medical progress in patients' houses, thanks to scientific and technological advances, as well as to the coordination of health and social professionals and caregivers made possible by the development of information and communication technologies. Telemedicine and telehealth consist in the transmission of medical data between health professionals or between a patient and his doctor. They represent useful tools for domomedicine, but they are usually focused on a single function or disease and/or do not propose social services (e.g., CorBene, Mein Herz, PTP, E-Cardicare, Patient Briefcase) [6]. Domomedicine implies simultaneously clinical and social aspects. Domomedicine may be seen as the step following the invention and spreading of telecare and telehealth devices. It is the technical and social system coordinating those technologies, to provide a complete health care solution at home. Deployment of domomedicine therefore represents a medical, economic and societal issue at European and international level.

In this context, the French domomedicine Consortium has been constituted in 2010 as a joint initiative of the Academy of Technologies and the Champagne-Ardenne region. Its ambition is to concretize domomedicine deployment. This led to the creation of the first pilot project PiCADO, launched in 2012. This research and development project has been labeled by a French innovation cluster, Systematic, and is co-funded by an inter-ministerial fund. The original PiCADO Consortium is composed of eight academic and industrial groups (including INSERM, Troyes University of Technology, and Altran as coordinator) who have been joined during the project by a number of other interested partners (hospitals, device manufacturers, service providers, health and training networks and associations, mutual insurance company, regional innovation agency) (see Figure 1).

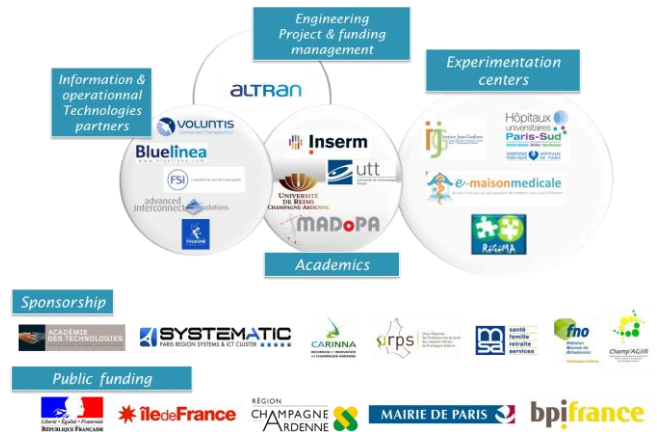


Figure 1. Stakeholders of the PiCADO project

The PiCADO project aims to design, develop, deploy and assess a domomedicine platform. This platform will allow integrated and personalized home monitoring and care, adapted to circadian rhythms, for patients with cancer and cognitive impairment with loss of autonomy. Indeed, recent chrono-biological research has shown that most of physical, physiological, psychological and behavioral parameters, such as exercise, rest [7], and body temperature [8][9], are regulated cyclically on 24 hours by a network of 15 specific genes. This network of molecular clocks is coordinated by a pacemaker, the supra-chiasmatic nuclei of the hypothalamus, which coordinates the various components of the circadian system and adjusts them to environmental cycles. In patients with cancer [9][10] and cognitive disorders [11], strong perturbations of the circadian rhythm have been shown in relationships with quality of life and survival.

Moreover, these two diseases differ both in their temporality (fast evolution for cancer, slow evolution for cognitive impairment with loss of autonomy) and organization of care (focused on hospital for cancer and on home for cognitive impairment with loss of autonomy). Those differences make them good candidate models to prove that PiCADO actually addresses multi-disease and multi-users' issue.

In Section II, we present the methodology used to develop the platform, and Section III describes the developed technological platform as preliminary results. To conclude, Section IV presents experimentation plans as short term perspectives.

II. METHODS

Use-case scenarios have first been specified with relevant stakeholders (including health professionals, patients and engineers) in multidisciplinary workshops, to adapt the platform to pathologies and users' needs. Those scenarios have been completed with a qualitative socio-anthropologic field analysis of current issues related to care support for both pathologies.

The platform has then been developed using a collaborative knowledge management process to extract important multi-dimensional information (technical, but also social, organizational, economical, legal aspects, etc.).

The PiCADO platform will be deployed in two different French regions (Ile-de-France and Champagne-Ardenne) with two hospitals and one health network, under an interregional multicenter clinical study that will cover initially 70 patients.

The methodology of evaluation will take into account medical, organizational, human, technical, economic, legal and ethical aspects, according to European and French guidelines and criteria (GEMSA, MAST).

III. PRELIMINARY RESULTS: THE PICADO PLATFORM

The PiCADO technological platform (see Figure 2) is a monitoring communicating platform which integrates several lightweight and portable technologies made interoperable (sensor, collector, geolocation watch, digital tablet, digital pen collector, information systems).

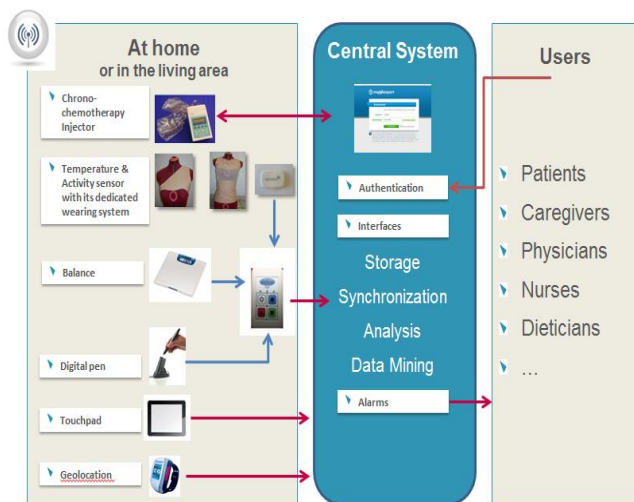


Figure 2. Architecture of the platform installed at home for patients with cancer/ cognitive impairment with loss of autonomy

The platform allows non-invasive and automatic collection of different markers of biological rhythms (activity, position, temperature) and health status of the patient (body weight, evaluation of the quality of life, geolocation, etc.) at home or during his daily activities. Most of the data is sent via Bluetooth to a collector box which transmits them via GPRS to a management server where they are stored securely in a patient's health record. Other devices such as touchpad and geolocation device are able to transmit data directly using the Internet or the mobile network. Authorized users can access record information via a secure web interface, add different type of patient information (health, nutrition, psychology, etc.) and communicate with other care givers via the same interface [12]. Automatic pre-analysis of data is coupled to notifications sending to care professionals, which they can reset. Tele-monitoring allows early detection of potential

health deterioration, and consequently better prevention. Data analysis also allows professional caregivers a better understanding of patients' rhythms, to adjust treatments and to propose adapted dietician or psychological services to their patients.

IV. CONCLUSION AND PERSPECTIVES

The objective of the platform is to minimize impacts of chronic disease on patient by acting on several levels: prevention of disease progression, centralization of patient information, and harmonization of coordination between general practice and hospital sectors, formal and informal caregivers, resulting in greater efficiency of care.

The deployment phase, planned for 2015, will allow the multidimensional assessment of the multi-pathology and multi-user values of the PiCADO system for all stakeholders (health professionals of general practice and hospital sectors, home and nutritional monitoring service providers, patient, family and informal care givers, industrials). Adapted business model will be designed through a first evaluation of the service delivered and through proof of concept of domomedicine. This study represents the first step of a nationwide and European deployment of domomedicine.

Furthermore, the clinical study will lead to the establishment of an original database on biological rhythms and symptoms of patients in their living environment. The detection of biological rhythms disturbances are expected to anticipate the deterioration in the condition of the patient and to avoid emergency hospital admissions. Detailed knowledge of the relationship between a patient's rhythms and his pathology evolution should eventually lead to personalized treatments. Moreover, the nutritional status monitoring should improve the prevention of health deterioration through early treatment of malnutrition which is an aggravating factor.

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