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How to improve the quality of the care of elderly subjects in nursing homes nowadays? Ger-e-Tech, a telemonitoring project dedicated to nursing homes

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Abstract:

The aim of the GER-e-TEC™ project is to study the contribution of telemonitoring residents in nursing homes of Rouen University Hospital, with a structuring and recording of medical care in order to avoid situations of acute decompensation and complication of geriatric risks.

E-care platform will provide personalized care for the main geriatric risks, to avoid the occurrence of an acute decompensation factor in the elderly patient. The collection of information by the platform will increase knowledge of the patients and provide a particularly effective tool for transmission between nursing staff and general practitioners in nursing homes. This information collection will allow the extraction of markers to improve the early detection of any decompensation and thus improve patient monitoring and reduce the number of hospitalizations. The platform will also provide any paramedical and medical health professional with the resident's geriatric data, which will be updated regularly, including the anthropometric, nutritional, cognitive and iatrogenic data, constituting a real illustration integrated into the electronic platform of the standardized gerontological evaluation, thanks to simple and non-time-consuming measures. Geriatric

risks will include the risk of falling, constipation, dehydration, confusion, iatrogenicity, undernutrition, heart failure, diabetes, infections and bedsores. This study will start in April 2019.

Key-words: Ger-e-TECH; geriatric syndrome; nursing home; ECARE platform

INTRODUCTION :

The European Union, and notably France, is experiencing population ageing. This development will jeopardize the future balance of public finance, including that of health care. Life expectancy at birth continues to rise worldwide, and in Europe, it is approaching or exceeding 85 years for women and 80 years for men. The quality of life in these extra years, experienced after age 80 or 85, is of increasing concern to authorities seeking to delay the onset of chronic diseases, senescence, functional decline, frailty and loss of autonomy. The growing number of elderly people in the French population causes increased usage of the healthcare system. In 1997, people aged 60 and over represented almost one-third of the total medical expenditure and almost half of drug expenditure, while making up only 20% of the total population. These figures highlight the impact of the increasing number of elderly people in our country.

The development of information and communication technologies (ICTs) for the elderly is a promising venture. They create new opportunities to assist and care for elderly people at home or in specialized institutions, including nursing homes and hospitals. Grouped under the term *gerontotechnology*, the first analyses of their contributions to this field appeared in the mid-1990s. Gerontotechnology examines technology and aging in order to improve living conditions and working environments, as well as medical care for dependent seniors.

Elderly and very elderly people living in nursing homes are frequently being hospitalized, more often than not in emergency situations, and the number is steadily increasing. To combat this problem, the French government has implemented a policy to increase accommodation by constructing new nursing homes across most regions of France. Thus, the number of patients admitted to hospital emergency departments from nursing homes continues to grow year after year, particularly for people in nursing homes with little medical attention that have no night care nurses, and that often have very limited medical time (coordinating doctors). Nursing home healthcare staff must be given tools to limit the flow of these poly pathological older patients to Emergency Services - such as assistance in the prevention of decompensation of some geriatric syndromes - to create a preventive policy and improve quality of life for the residents. Literature data supports this: trips to Emergency Units cause increased rates of morbidity and mortality.

Increasing numbers of elderly subjects, increasing occurrence of comorbidities:

Since 2012, Europe's working age population has been shrinking while the number of people aged 60 or over continues to grow. By 2060, one-third of French people will be over 60 years of age and 5 million will be over 85, compared to 1.4 million today. Life expectancy from birth continues to increase around the world, approaching or exceeding 85 years for women and 80 years for men in Europe [1]. Today's nursing home residents are poly pathological (heart failure, diabetes, COPD, renal insufficiency, etc.) and polymedicated. At a medical level, this implies the need for regular monitoring and a high level of medical or multidisciplinary expertise for the healthcare team.

A person over the age of 75 often has:

- a functional reserve of vital organs reduced by advancing age,
- various chronic diseases,
- various drug treatments.

The number of preventable Emergency Unit hospitalizations is increasing every year in France, especially for elderly people residing in nursing homes. They make frequent use of the hospital, and most often in cases of emergency.

According to the EHPA survey conducted by the Directorate for Research in Evaluation and Statistical Studies (DRESS), there were 728,000 people residing in nursing homes in France at the end of 2015 [2]. The elderly are increasingly entering nursing homes and becoming more dependent after entering; as the 2011 Morley study shows, the proportion of residents in the GIR (Iso-resource Group) ranked from 4 to 1 accounted for 91% [3]. According to the results of a 2015 national analysis conducted in nursing homes by ANESM (*Agence Nationale de l'Evaluation et de la qualité des établissements et Services sociaux et Médico-sociaux*, National Agency for Assessment and Quality of Institutions and Social and Medical-Social Services), more than half of these residents are admitted to hospital each year for an average stay of about three weeks, after being passed through Emergency Services [4].

Visits to Emergency Units are frequent for nursing home residents, with one in four admitted at least once a year and one in ten at least twice a year [5]. According to the HCAAM (*Haut Conseil pour l'Avenir de l'Assurance Maladie*, High Council for the Future of Health Insurance),

hospitalizations for this population cost 1.7 billion euros per year in health insurance [6]. Emergency hospitalizations for nursing home residents are considered preventable, according to the authors, in 7 to 67 percent of cases [7], and their frequency could be reduced by improved decision-making procedures. Causes of preventable hospitalization include lack of medical availability and lack of communication between paramedics and healthcare physicians [8].

To explain the geriatric phenomena, it is necessary to understand the Bouchon 1-2-3 model [9]:

- 1- The effects of aging that gradually reduce functional reserves, without ever leading to decompensation.
- 2- The superimposed chronic conditions that alter the functions.
- 3- Decompensation factors that often co-occur in the same patient: acute medical conditions, iatrogenic pathology and psychological stress.

For example, the effects of aging on the brain promote the confusional state, acute cerebral decompensation. Chronic neuropsychiatric conditions, including dementia, are the main areas. Its triggering factors are many: disorders that are cardiovascular, metabolic or infectious, and iatrogenic and environmental stress.

Prolonged life expectancy is real and we are witnessing the growing importance of anticipatory medicine, i.e. preventive medicine.

Telemedicine: towards a preventive medicine

According to the Public Health Code, *telemedicine* is defined as a form of remote medical practice that uses information and communication technologies. It connects one or more health professionals to themselves or to a patient; this includes a medical professional and, where appropriate, other professionals providing patient care. It allows healthcare professionals, with or without their patient's presence, to connect with one another, or with specialists involved in the patient's care.

Telemedicine is a recent development in healthcare, enabled by technological progress and promoted by public authorities due to its potential possibilities, including: improved

accessibility to care, optimized use of professionals' time, improved collaboration between professionals, optimized care pathways, and revived innovation in therapeutic treatment plans.

Telemedicine has shown its effectiveness in the management of chronic diseases, such as heart failure and high blood pressure, among others. Monitoring patients with chronic diseases through the use of telemedicine is a way to optimize their care. It also offers a better quality of life for elderly patients. Telemonitoring could lead to a significant reduction in the number of readmissions, which would consequently result in lower costs for society. These solutions also encourage the accurate collection of medical data to enable improved monitoring of patient health. The objectives are thus ambitious, ranging from improved rates of morbidity and mortality, to decreased readmissions, improved quality of life and reduced economic costs.

Telemedicine has shown efficacy in the treatment of chronic diseases such as heart failure and high blood pressure. The monitoring of patients with chronic pathologies through telemedicine systems is one way of optimizing their care [10]. Telemonitoring would significantly reduce the number of re-hospitalizations that directly correlate to social costs, while also promoting a better quality of life in elderly patients. Further, these solutions promote the collection of precise medical data that permits adaptive monitoring of a patient's state of health. The objectives are thus ambitious, ranging from improvements in the morbidity-mortality rate to decreased re-hospitalizations, increased quality of life and reduced medico-economic costs.

Telemonitoring is a branch of telemedicine that aims to give home autonomy to people suffering from various pathologies and disabilities that would normally force them into hospitalization or placement in specialized institutions, such as patients suffering from certain chronic diseases, the disabled, and also dependent older persons [11].

Telemonitoring is a medical procedure that comes about from the transmission and interpretation of a clinical, radiological or biological indicator, collected either by the patient or by a health professional [12]. Interpretation can lead to the decision to treat the patient. Today, this is done by a doctor who may delegate a future course of action to another health

professional based on a written protocol for monitoring the said indicator that has been validated by the attending physician or a called-upon physician. The medical time devoted to monitoring a chronic disease indicator is not the same as that which a doctor must devote to the diagnostic procedure or to therapeutic education. Telemonitoring a patient with a chronic disease is based on the regular monitoring of one or more indicators that lets the attending physician know whether or not the patient's disease is stabilized. Any possible destabilization of the indicator is immediately corrected to prevent complications that would justify hospitalization. Telemonitoring provides appropriate responses to the monitoring of most chronic diseases by avoiding the multiplication of traditional consultation procedures and by shortening the length and repetition of hospital stays. The advantages of medical telemonitoring - minimized risk of acute decompensation of the chronic pathology, decreased re-hospitalizations and their economic costs, more appropriate medical monitoring, and a greater commitment to the patient in the management of their pathology - result in better therapeutic compliance and quality of life [13]. The relevant indicators are digitally transferred (via internet, network) for interpretation by a doctor, who must be the custodian of the professional medical record. The result of the indicator is recorded therein, and any possible prescription resulting from it is also recorded. The transfer of these indicators must be secure. Integrating telemonitoring into the care system of a chronically ill patient can help prevent certain complications and unplanned hospitalizations. For example, the rate of hospitalization of patients over the age of 70 with chronic heart failure has increased by 30% over the last ten years [13]. In Quebec, home telemonitoring of heart failure has reduced the rate of hospitalization by more than 60% [13]. Limoges University Hospital participates in the Icare project, a pilot research study that evaluates the effectiveness of home telemonitoring for elderly people with chronic diseases. Unique to Europe, its aim is to prevent the loss of home autonomy for elderly people by demonstrating that remotely monitoring chronic diseases in elderly patients avoids decompensation (disruption of balance) and unplanned hospitalization. The study is being conducted over a 12-month period with 500 elderly volunteers, some of whom will benefit from remote monitoring using biometric sensors installed in their homes. These (non-worn) sensors monitor constants, such as blood pressure, blood glucose, weight, blood oxygenation rate and temperature, and transmit the data securely to the patient's attending physician and nurse, as well as to the geriatric doctor at the hospital, each day [14]. Further work has focused on medical telemonitoring. Minutolo *et*

al. offer a decision support system for telemonitoring of people with heart failure [15]. The system is based on an ontology that groups together patient-related data such as posture, heart rate, physical activity, and alerts. Franco *et al.* worked on a telemonitoring study of elderly people with Alzheimer's disease [16-17]. Their system detects drifts in nycthemeral rhythms from the location data. The study by Edirippulige S *et al.* suggests there is little evidence to support telemedicine, but this only represents one randomized study [18]. In addition, most studies are observational and qualitative, as well as use-oriented. They are mainly based on surveys and interviews of stakeholders (patients and health staff). Some studies have evaluated the costs associated with implementing telemedicine services. The study by Edirippulige S *et al.* shows evidence of the feasibility of telemedicine in long-term care facilities in a number of clinical specialties, including geriatrics [18].

With respect to **cost**, this study makes the following observations:

- In **medical coordination**, the management of telemedicine patients becomes economically affordable when usage exceeds about 850 per year;
- In **dermatology**, tele-expertise proves to be most profitable;
- In **geriatrics**, geriatric assessment and patient education seem to be the most cost-effective.

Telemedicine is likely to help or even optimize the care of elderly patients by avoiding certain emergencies and repeated hospitalizations [19].

GER-e-TEC: Telemonitoring project for elderly residents in nursing homes

With this in mind, we set up the Ger-e-Tech project to study the telemonitoring of residents in Rouen University Hospital nursing homes. Through the structuring and recording of medical care, we aim to avoid situations of acute decompensation and complications of geriatric risks.

Our objective is to develop a codified, preventive approach for the management of major geriatric risks in nursing homes using a personalized telemonitoring platform dedicated to the residents, in order to avoid the occurrence of an acute decompensation factor in the elderly. The collection of information by the platform will not only allow personalized monitoring but will increase patient knowledge and provide a particularly effective tool for

transmission between nursing staff (doctors, nurses, etc.) in nursing homes, thus allowing continuity of care. The collected data will also extract markers to improve early detection of any decompensation, thereby improving patient monitoring and reducing hospitalizations. Further, this work will allow for the creation of resident liaison files, providing any paramedical and medical health professional with the resident's up-to-date geriatric data, including anthropometric, nutritional, cognitive and iatrogenic data. Thanks to a simple and streamlined approach, this constitutes a real illustration integrated into the electronic platform of the standardized gerontological evaluation. Geriatric risks will include the risk of falling, constipation, dehydration, confusion, iatrogenicity, undernutrition, heart failure, diabetes, infections and bedsores.

The project's objective is to experiment with recorded personalized medical monitoring of Rouen University Hospital nursing home residents using the E-care [20] intelligent telemedicine platform, winner of the Investissements d'Avenir (Future Investments) in 2012 and the Fondation d'Avenir (Future Foundation) in 2015 and 2017. The platform assists caregivers by automating the processing of information from sensors and questionnaires to detect anomalies and make early diagnoses of medically risky situations. E-care will provide personalized care for major geriatric risks to avoid the occurrence of an acute decompensation factor in elderly patients. The information collected will be supplemented by codified therapeutic management that follows international recommendations, for direct use in nursing homes. The project will rely on a multidisciplinary team built on the necessary medical, scientific and structural skills. The E-care platform uses an intelligent algorithm to process data and generate alerts based on medical knowledge of the pathologies treated and modeled by ontologies. The general principle adopted by this platform is the anticipation of decompensation through the detection of warning signs that ultimately lead to hospitalization. Tested at the Strasbourg University Hospital from 2013 to 2014 and in homes in 2015, the platform is currently deployed in the PRADO-INCADO project in Strasbourg (a collaborative project between the Strasbourg University Hospital, the Bas-Rhin Medical Insurance and the Grand-Est Regional Health Agency) to monitor heart failure patients where they live.

In fact, Andrès et al. developed a telemedicine project called E-Care, dedicated to "the early detection of risk situations in heart failure patients" (PIA, 2014) [20]. This detection is based

on: a web-connected touch-screen tablet; non-intrusive sensors (arterial pressure, heart rate, oxygen saturation, weight); questionnaires; and artificial intelligence.

The system (Fig. 1) involves a server that hosts the patient's data and a secure internet portal to which the patient and hospital as well as non-hospital based healthcare professionals can connect. E-care is based on a smart system consisting of an inference engine and medical ontology for personalized synchronous or asynchronous analysis of data that is specific to each patient with, as necessary, the sending of an AI-generated alert.

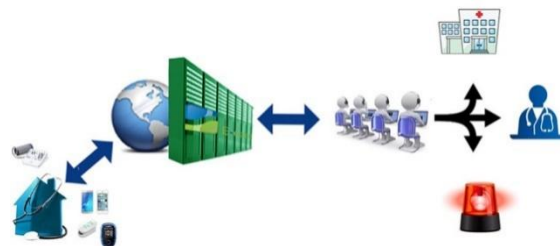


Fig. 1. E-care platform.

The E-care telemonitoring platform was rolled out with patients in the context of an experiment directed by the University Hospitals of Strasbourg (Hôpitaux Universitaires de Strasbourg, HUS, Strasbourg). This graphic was developed in collaboration with the University of Technology of Belfort-Montbéliard (Université de Technologie de Belfort-Montbéliard, UTBM) and PREDIMED Technology.

During this experiment, the E-care telemonitoring platform was used daily by patients and by health care professionals according to a set usage protocol tailored to each patient. The average age of these patients was 72 years, with a male/female ratio of 0.7. These patients present with multiple conditions, with a Charlson Comorbidity Index of 4.1. Among the most frequent conditions were: heart failure in over 60% of these individuals; anemia in over 40%; atrial fibrillation in 30%; type 2 diabetes in 30%; and chronic obstructive pulmonary disease (COPD) in 30%.

More than 1,500 measurements were taken from these 175 patients, causing the E-care system to generate 700 "alerts" regarding 68 patients. During the monitoring period, 107 individuals (61.1%) had no "alerts." The follow-up study on those 107 patients shows that they presented no clinical health event that could result in hospitalization. An analysis of the alerts shows that the E-care platform makes it possible to automatically and non-intrusively

detect a decline in the patient's health status, in particular cardiac decompensation. Indeed, it is in this last situation that the system offers the best sensitivity (Se) and specificity (Spe) values, as well as positive and negative predictive values (PPV and NPV): 100%, 72%, 90%, and 100% respectively.

The E-care project is, to our knowledge, the first such program rolled out for heart failure patients who are elderly (average age: 72), have multiple medical conditions, and belong to the geriatric population (Charlson Comorbidity Index: 4.1), using a telemedicine solution for early detection of situations that could lead to acute decompensation. In this sense, we are in the realm of predictive medicine, which, in the context of the E-care platform, aims to be increasingly personalized, which is to say, adapted to the phenotype of each patient. For the practitioner, this means that the E-care telemonitoring platform makes it possible to detect 100% of cardiac decompensations and that three-quarters of alerts refer to such cases. Only 10% of the alerts lack a direct relationship to heart failure.

To date, this is the first time that such a communicative, "smart" system has been built upon new technological tools, anticipating Telemedicine 2.0 solutions. All of the patients, including the most fragile among them, and the health care professionals used the E-care system without difficulty through the end of the experiment. During the experiment on non-autonomous patients, the system was used by a nurse, in addition to his/her other duties (washing, injection of various medications, etc.), or by the patient's family, friends, or caregivers. It should be noted that the tools and the system were tested and developed in advance by patients and professionals at the National Information Technology Center for Autonomy (Centre d'Expertise National des Technologies de l'Information et de la Communication pour l'autonomie, "Centich," Angers). As in this experiment, age did not appear to be a limiting factor in acquiring and using these new technologies.

This platform is in the process of being certified as an EU Medical Device and the DIABETe platform has recently been accredited by the Alsace BioValley Competitiveness and Innovation Centre.

We currently develop a series of measures and questions to be integrated into the E-Care platform and use an upgraded version of the E-Care Platform for the personalized and adaptive monitoring of patient health in nursing homes. This study, starting in September

2018, is supported by the CENTICH (Centre d'Expertise National des Technologies de l'Information et de la Communication pour l'autonomie, National Expertise Centre for Information Technologies and Communication for Autonomy).

CONCLUSION

Applications for telemedicine are progressively expanding to incorporate Geriatrics, and more projects should be delivered in the coming years. The various projects have a variety of different aims, but preserving the quality of life of these elderly subjects, in nursing homes is a particularly widespread priority. Our team is currently striving to develop, via an upgraded version of the E-Care Platform, of remote monitoring of geriatric risks applied to residents of nursing homes in the *Rouen University Hospital* with the aim of reducing preventable hospitalizations through emergency medicine and preventing the occurrence of geriatric risks in advance. Once again, as in the case of cardiac failure, this project will make use of artificial intelligence and alerts that are specific and adapted to each individual resident in nursing home.

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