



Telemedicine in Elderly Patients: The Time of Maturity with Telemedicine 2.0! A Short Review with a Focus on the E-Care Project

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Introduction

The rising prevalence of chronic diseases, e.g. Chronic Heart Failure (CHF) combined with population aging now represents a very real problem for public health [1]. CHF affects more than 15 million Europeans, mostly the elderly. The cost of these chronic diseases has rocketed, and is estimated at several billion dollars in developed countries. What's more, these patients are often elderly and have one or more chronic diseases, and their management is a challenge for healthcare professionals. Their needs eat up large amounts of medical resources, just as a shortage in the time careers can provide is beginning to be felt, with medical deserts and a lack of access to healthcare professionals, among other problems. Thus, our societies must “reinvent the medicine of today and also of tomorrow”! In this setting, telemedicine is a promising solution [2]. In this paper we realize a short review on telemedicine projects dedicated to patients with chronic heart failure, especially in elderly patients.

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Telemedicine in Chronic Diseases

Despite the advances in treatment of recent years, most chronic pathologies, e.g. CHF, *diabetes mellitus*, or chronic obstructive pulmonary disorders, remain serious diseases in terms of their functional or survival prognosis, and morbidity and mortality are high [1].

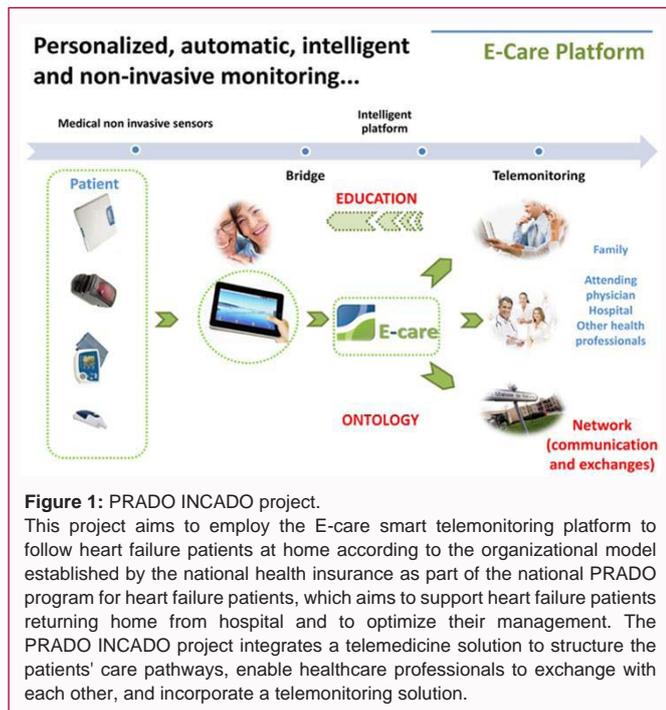
This applies particularly well to CHF, in which the mortality rate of patients with stage III-IV disease according to the New York Heart Association (NYHA) classification is at least 30% at 5 years in more recent studies. CHF patients frequently present for emergency hospitalization and re-hospitalization, which impairs the quality of their life. Some of these hospitalizations could be avoided if patients took greater responsibility for their disease and were followed up better. This last point has been particularly well documented in CHF and *diabetes mellitus* [2].

Telemedicine may be of aid in this setting. Indeed it may even optimize the management of such chronic diseases, particularly by preventing emergency and repeat hospitalizations [2]. It may also make it possible to structure integrated care pathways.

“Telemedicine 1.0” Projects in Chronic Heart Failure

Since the beginning of the 2000's, numerous telemedicine projects have been conceived and developed in the area of CHF [3-21]. Practically all of them have investigated telemonitoring also known as tele management. Some of the projects have very specifically investigated CHF subjects aged over 75 or over 80 [4,20]. The results of those CHF telemedicine projects differed from study to study and were fairly inconclusive regarding any potential clinical benefit in terms of, for instance, CHF re-hospitalization or a decrease in morbidity and mortality.

Nevertheless, several reviews and meta-analyses seem to have shown an undeniable utility for CHF telemedicine [2,14]. Moreover, aside from the medical considerations, it is worth noting that



all the studies seem to agree that using telemedicine solutions in the management of CHF was at least economically beneficial [2,14]. Depending on the study, the savings were calculated to be between \$5000 and more than \$50,000/year/patient depending on the stage of heart failure and the setting of the study.

It is worth bearing in mind that those CHF projects [3-21], particularly the earlier ones, more closely resembled telephone follow-up with care providers (such as a nurse) traveling to the patient's home, rather than telemedicine as we think of it nowadays with nonintrusive, automated, smart telemonitoring using remote sensors via modern communication technology or even artificial intelligence [18]. Hence in our opinion those studies represent the first generation of CHF telemedicine projects: "telemedicine 1.0".

In their review of telephone follow-up or telemonitoring of heart failure patients, Inglis and colleagues [14] found that telemedicine had an effect on all-cause mortality, which fell significantly by 34% ($p < 0.0001$). In that study, the authors also revealed that re-hospitalization for heart failure fell by 20%, that the quality of life of patients and cost of management improved, and that the system was well accepted. In the meta-analysis by Anker and colleagues [2], 11 studies were analyzed as part of a comparison between the effects of telemonitoring and routine care (non-invasive telemedicine). Their research revealed that telemonitoring led to a reduction of all-cause mortality (10.4% vs. 15.4%; $p < 0.0001$), all-cause hospitalization (47.2% vs. 52.1%; $p = 0.02$), and hospitalization for chronic heart failure (22.4% vs. 28.5%; $p = 0.008$).

Conversely, two prospective clinical trials, the "gold standard", have produced results that contradict the previous ones and question the potential utility of telemedicine in heart failure [18,19]. The Tele-HF study randomized patients hospitalized for heart failure to telemonitoring ($n = 826$) or standard care ($n = 827$) [15]. The study found no significant difference between the telemonitoring and standard management groups in terms of all-cause readmission or all-cause mortality in the 180 days after inclusion (OR: 1.04 [CI95%:

0.91-1.19]). The TIM-HF study in Germany randomly compared two groups of patients with stable heart failure, namely those followed by telemonitoring ($n = 354$) and those receiving standard care ($n = 356$) [16]. In that study, the all-cause mortality rate was 8.4 per 100 patient-years of follow-up in the telemedicine group and 8.7 per 100 patient-years of follow-up in the standard care group (OR: 0.97 [CI95%: 0.67-1.41]; $p = 0.87$).

Recently, an educational, home-based study of patients with CHF in Lower Normandy (in France), has researched the relevance of telemedicine [2]. The structure of the SCAD study is organized around the patient and is based on the collection of data entered by the patient and sent to the educational center. It is part of a prospective, randomized, open-label, multi-center trial evaluating the impact of educational telemedicine aftercare for 3 months in 73 patients over 65 years old and hospitalized for acute heart failure (LVEF $< 45\%$). By the end of this study, 1,040 days of hospitalization from acute heart failure had been registered. The educational telemedicine aftercare was able to reduce the number of days, with 450 days in the telemedicine group compared to 590 days in the control group. Quality of life parameters improved equally in both groups. Importantly, the study noted a significant decrease in cardiovascular mortality.

"Telemedicine 2.0" Projects In Chronic Heart Failure

Over the last 4 to 5 years, a second generation of projects has emerged in the CHF area, particularly in developed countries [18]. These projects are known as "telemedicine 2.0", because they utilize the new Information and Communication Technology (ICT) and the web. Most of these projects rely on the usual connected tools for monitoring heart failure, such as blood pressure meters, weighing scales, and pulse oximeters, which relay the information collected via Bluetooth, 3G or 4G and incorporate tools for interaction between the patient and healthcare professionals like telephone support centers, tablets, and websites [18]. Some of them also provide tools for motivation and education, and occasionally, questionnaires about symptoms, such as dyspnea, palpitation and edema as experienced by the patient.

In this setting, we have developed a "telemedicine 2.0" project, named E-care telemonitoring project, in Strasbourg, France [21,22]. The E-care project has been developed to optimize the home-monitoring of CHF patients. It detects situations in which there is a risk of cardiac decompensation and re-hospitalization, and it does this via a "telemonitoring 2.0" platform (Figure 1). This later generates indicators of a worsening of the patient's health status. These "warning alerts" are generated for any decompensation of the CHF that may lead to hospitalization if not treated. Between February 2014 and April 2015, the E-care platform has been used in 175 patients with CHF in the Strasbourg University Hospital [22]. During this period, the E-care platform was used on a daily basis by patients and healthcare professionals according to a defined protocol of use specific to each patient. During the study, the E-care system generates 700 alerts in 68 patients. Analysis of the "warning alerts" showed sensitivity, specificity, and positive and negative predictive values, respectively of 100%, 72%, 90% and 100%. In this experimentation, the E-care platform automatically and non-intrusively detected any worsening of the patient's health, particularly cardiac decompensation.

As in other telemedicine projects [4,24], elderly patients, event among 80-year-olds or the frailty, have adopted the "telemedicine



Figure 2: PRADO INCADO project.

This project aims to employ the E-care smart telemonitoring platform to follow heart failure patients at home according to the organizational model established by the national health insurance as part of the national PRADO program for heart failure patients, which aims to support heart failure patients returning home from hospital and to optimize their management. The PRADO INCADO project integrates a telemedicine solution to structure the patients' care pathways, enable healthcare professionals to exchange with each other, and incorporate a telemonitoring solution.

2.0" solution without any problem. The mean age of the patients included in E-care is 72 years. These patients suffered from multiple concomitant diseases and had a mean Charlson index of 4.1. Both the healthcare professionals and all the patients, even the frailest, used the E-care system without difficulty until the end of the study. During the study of non-autonomous patients, the system was employed by a nurse in addition to other tasks like washing and administering medication, as well as by close ones and family members. Hence, it has been our experience that age is not a limiting factor on grasping and using new technologies.

Moreover the telemedicine is capable of structuring the patients' care pathways, a major theme in medicine for our governments and authorities; it is also capable of providing a means for the various healthcare professionals to exchange with each other; and of facilitating access to medical resources. With this in mind, an enhanced version of the E-care platform will be experimented in the homes of heart failure patients as part of a project called PRADO INCADO. PRADO is a French program to support patients returning home after hospital, while PRADO INCADO will specifically target heart failure patients in this setting with the support of the E-care platform (Figure 2). The project is being run by a group bringing together Strasbourg University Hospital, the Alsatian Regional Health Agency, the Bas-Rhin branch of France's National Health Insurance, and the company PREDIMED Technology.

Perspectives in Geriatrics

Besides heart failure, the opportunities in geriatrics revolve around developing new versions of E-care to enable "global" telemonitoring of elderly subjects in nursing homes or at home, as opposed to single-disease telemonitoring as currently offered by a large number of telemedicine projects and solutions [18]. As with E-care, the "telemedicine 2.0" projects are perfectly compatible with the care

pathways being developed in chronic diseases by the developed countries health authorities. What's more, all these findings should be analyzed with regard to the benefit of these telemedicine solutions. This experience may lead us to witness the birth of the medicine of tomorrow. In the field of chronic diseases, given the epidemiology and expected shortage of time careers can provide, what we need is better follow-up and better education, improved prevention and anticipation, but, above all, better selection of the patients whose use of the healthcare system will be indispensable.

Conflicts of Interest

The authors state that they have no conflicts of interest to declare except Mr. M. Hajjam, who is the science director of the company PREDIMED Technology.

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