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Telemedicine in Elderly Patients with Chronic Heart Failure: Narrative Review of the Literature with a Focus on Telemedicine 2.0 Projects

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Authors' contributions

This work was carried out in collaboration between all authors. Authors EA, ST, MH and AH designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors EA, AAZ, MH and AH managed the analyses of the study. Authors EA, AAZ, ST, MH and AH managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: This is a narrative short review of the literature pertaining to telemedicine projects developed in the field of heart failure, with special attention to the remote monitoring project called E-care, a French telemedicine of new generation program to support patients returning home after hospital. This project has been specifically designed to automatically detect situations at risk for heart failure. Prospects for the development of the E-care system in the field of Geriatrics will likewise be discussed.

Results: Numerous telemedicine projects, based on connected objects or information and communication technology (ICT), have emerged over the last five years or are under development in the field of computer science heart failure. This is the case of the E-care telemonitoring project, which fits perfectly within the framework of telemedicine 2.0 projects, including for the first time artificial intelligence (AI). Their potential contribution in terms of mortality or morbidity, in addition to number of hospitalizations avoided, is currently under study or documentation. Their impact in terms of health economics is also being validated, taken into account that the oldest telemedicine projects had already validated the economic and social benefits brought up by telemedicine solutions.

Keywords: Telemedicine; artificial intelligence; information and communication technology; heart failure; geriatrics.

1. INTRODUCTION

The rising prevalence of chronic diseases like heart failure combined with population aging now represents a very real problem for public health [1]. In France, more than one million people suffer from heart failure, and a large majority of those are elderly. French heart failure patients have a mean age of more than 75 years. Three quarters of heart failure sufferers are aged over 65, and more than a third over 75 [1,2]. Between 120 000 and 150 000 new cases are diagnosed every year [2]. The cost of this chronic disease has rocketed, and is estimated at several billion dollars in developed countries [1]. What's more, these patients are often elderly and have one or more chronic diseases, and their management is a challenge for healthcare professionals [1]. 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. Our societies must reinvent the medicine of today.

Despite the advances in treatment of recent years, most chronic pathologies remain serious diseases in terms of their functional or survival prognosis, and morbidity and mortality are high [1]. This applies to heart failure, in which the mortality rate of patients with stage III–IV disease according to the New York Heart Association (NYHA) classification is 50% at 5 years (although closer to 30% in more recent studies) [2,3]. Heart failure patients frequently present for emergency hospitalization and re-hospitalization, which impairs the quality of their life [1,2]. Heart failure is thus responsible for more than 100 000 hospitalizations per year in France [2]. It accounts for 5% of all hospitalizations and is the main cause of hospitalization among elderly subjects [2]. Some of these hospitalizations could be avoided if patients took greater responsibility for their disease and were followed up better [1]. This last point has been particularly well documented in heart failure and diabetes [1,4]. 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 [2,4]. It may also make it possible to structure integrated care pathways, with, again, the most important evidence to be found in heart failure [4] as well as, to a lesser extent, in diabetes [5].

In this article we review the literature on telemedicine projects, particularly telemedicine 2.0, developed in the area of heart failure, especially in the elderly (at least older than 65 years). We report our experience of a telemonitoring project called E-care, which focused on early detection of situations involving a risk of cardiac decompensation. The possibilities for developing such a system in the area of geriatrics will also be discussed.

2. SEARCH STRATEGY

A literature search was performed on the PubMed database of the US National Library of Medicine and on Scholar Google. We searched for articles published between January 2010 and January 2018, using the following key words or associations: “heart failure”, “telemedicine”, “e-Health”, “telemedicine in heart failure” and “e-Health in heart failure”; restrictions included: English- or French-language publications; published from Jan. 1, 2010, to Jan. 31, 2018; human subjects; clinical trials, review articles or guidelines. All of the English and French abstracts were reviewed by at least two senior researchers from our work group. After rigorous selection, only 20 papers and fewer than 10 projects under study were selected and analyzed. The latter (references [4-35]) were used to write this paper in the form of a narrative short review.

Textbooks of Telemedicine, American Society of Cardiology books, European Society of Cardiology books, and information gleaned from international meetings were also used, as information gleaned from commercial sites on the web.

3. FIRST-GENERATION TELEMEDICINE PROJECTS

Since the beginning of the 2000’s, numerous telemedicine projects have been conceived and developed in the area of heart failure [6-22]. Practically all of them have investigated telemonitoring (or tele management, as it is also known) with a focus on heart failure patients, as defined under French legislation [23]. To our knowledge, no completed projects have been published on tele-consultation and tele-expertise in the area of heart failure. Some of the projects have very specifically investigated heart failure subjects aged over 75 or over 80 [24,25]. It is worth bearing in mind that those projects, 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 [4,21]. Hence in our opinion those studies represent the first generation of telemedicine projects [4,15].

As we will see, the results of those telemedicine projects differed from study to study and were fairly inconclusive regarding any potential clinical benefit in terms of, for instance, re-hospitalization or a decrease in morbidity and mortality. This particularly applied to the statistical significance of the results. Because of this, the experts had divided opinions about the utility of telemedicine in the management of heart failure patients. It should also be pointed out that the studies were conducted with sometimes inappropriate methodologies, in unsuitable patient groups (such as NYHA Stage-I heart failure) and, above all, in small patient samples (of between 50 and 1000 patients) with very short follow-up periods (of between 3 months and 1 year). In our opinion, this made any clinical benefit they demonstrated illusory [4,21]. Despite these limitations, several reviews and meta-analyses seem to have shown an undeniable utility for telemedicine [3,17].

For instance, in their review of telephone follow-up or telemonitoring of heart failure patients, Inglis and colleagues [17] 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 [4], 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) [18]. 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 (odds ratio [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)

[19]. 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).

Aside from these medical considerations, it is worth noting that all the studies seem to agree that using telemedicine solutions in the management of heart failure was at least economically beneficial [6-21]. 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. For instance, in the study by Scalvini and colleagues [22], the cost of managing heart failure patients fell by 24%, and hospital costs fell by €45,186/patient/year.

For the most part, the patients included in the studies that we have just seen were unrepresentative of the geriatric population [6-22]. An insignificant number of them were over 75 years old. On top of that, most of the patients were elderly subjects in very good health with little comorbidity. Yet, there are some studies in the literature with patients aged over 80 [24,25]. Unfortunately, these studies yielded no conclusive results in terms of morbidity, mortality, and other causes of re-hospitalization. That said, the results suggested that telemedicine was feasible in the geriatric population and that the telemedicine solutions offered were used. The study by Burdese and colleagues [25] is one of the most convincing for illustrating the utility of tele management in elderly heart failure patients. The authors of that study documented its usefulness in 48 subjects with a mean age of 80.4 ± 7.7 years suffering from severe and refractory heart failure followed up for 20 months. A significant fall was observed in re-hospitalization (35 without *vs.* 12 with telemedicine, *p* = 0.0001), in visits to the emergency department for an acute episode of heart failure (21 *vs*. 5/year, *p* = 0.0001) and in the cost of management (€116,856 *vs.* €40,065/year). What's interesting is that only 8.6% of the patients discontinued tele management, showing that it was well accepted.

4. SECOND-GENERATION TELEMEDICINE PROJECTS

Over the last 4 to 5 years, a second generation of projects has emerged in the heart failure area, particularly in France [21,26-31]. These projects are known as "telemedicine 2.0", because they utilize the new Information and Communication Technology (ICT) and the web. They satisfy the conditions of telemedicine as laid out in France in Article 36 of the Social Security Financing Act [5].

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 [21]. 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.

The main telemedicine 2.0 projects currently being developed in France are:

- SCAD: "*Suivi CArdiologique à Distance*" [remote cardiological follow-up], first initiated in 2005, deployed in the low Normandie, France between 2009 April and May 2012, developed by Caen University Hospital [26];
- PIMPS: "*Plateforme Interactive Médecins patients Santé*" [doctor–patient interactive health platform], initiated in 2013, developed by René-Dubos hospital in Pontoise, France, and Professor Jourdain [27];
- OSICAT: "*Optimisation de la Surveillance ambulatoire des Insuffisants CArdiaques par Télécardiologie*" [optimization of outpatient monitoring in heart failure patients using telecardiology], initiated in 2012, involving 12 local investigation centers coordinated by Toulouse University Hospital and Professors Galinier and Pathak [28];
- MEDICA: "*Monitorage Electronique à Domicile de l'Insuffisance CArdiaque chronique*" [electronic home-monitoring of chronic heart failure], initiated in 2014, developed by the REUNICA domicile and GMC-solutions santé groups working in social protection of the elderly [29];
- E-care: "*Détection des situations à risque de décompensation cardiaque chez les patients insuffisants cardiaques de stade III de la NYHA*" [detection of risk situations for cardiac decompensation in heart failure patients with NYHA stage-III disease], initiated in 2014, the medical aspects of

which were developed by Strasbourg University Hospital [30,31].

All these projects are run with the aid of the telemedicine 2.0 tools discussed above. The PIMPS project also comprises laboratory monitoring of natriuretic peptide [27]. These projects center on cohorts of heart failure patients or prospective studies. They have enrolled relatively large patient samples, and most of them are based on data from evidence-based medicine. The OSICAT study seems the most advanced [28]. It was launched in 2013 and has enrolled 990 patients divided into two groups, remote home-monitoring and controls receiving standard care. The results will include an assessment of medical efficacy and cost-effectiveness, and are expected in 2018. To our knowledge, only E-care project includes artificial intelligence tools [30,31].

To date, clinical results are only available for SCAD and E-care projects [26,31] In the SCAD project, 90 patients were randomized from 2009 April to 2011 May (n=45 for each group) (Thesis from the Faculty of Medicine from Caen, France). The population is elderly, with a mean age of 78 ± 6 years, mostly male (78%) and at high risk of re-hospitalization (mean BNP level of 1,025 ± 950 pg/mL). At 12 months, 1,040 days of hospitalization for acute heart failure were recorded. Monitoring by educational telemedicine significantly reduced the number of hospital days for acute heart failure: 590 days in the “control group” *vs.* 450 days in the “telemedicine group” (p = 0.044). The criterion "death or hospitalization for acute heart failure" occurred less frequently in the telemedicine group: 57.8% in the “control group” *vs.* 35.6% in the “telemedicine group” (p <0.05). During heart failure readmissions, telemedicine-treated patients had lower intra-hospital mortality: 18.2% vs. 0% (p <0.02).

5. E-CARE TELEMONITORING PROJECT

The E-care telemonitoring project in Strasbourg falls under this category of telemedicine 2.0 [30,31]. It has been developed to optimize the home-monitoring of heart failure 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. The E-care platform automatically generates indicators of a worsening of the patient's health status. These "warning alerts" are generated for any decompensation of a chronic disease (particularly heart failure) that may lead to hospitalization if not treated. To our knowledge, it is the first project that used artificial intelligence (AI) in addition to information and communication technologies.

As illustrated in Fig. 1, the platform makes use of nonintrusive medical sensors that record blood pressure, heart rate, oxygen saturation and weight [30,31]. These sensors are connected by Bluetooth and relay real-time physiological data about the patient's health status. The platform also includes a touchscreen tablet that is connected by Wi-Fi and a router or 3G/4G, making it possible to interact with the patient and provide education on treatment, diet and lifestyle. The E-care system includes a server that hosts the patient's data and a secure Internet portal to which the patient and the various hospital- and non-hospital-based healthcare professionals can connect. E-care is based on a smart system comprising an inference engine and a medical ontology for personalized synchronous or asynchronous analysis of data specific to each patient and, if necessary, the sending of an alert generated by AI [32].

The E-care telemonitoring platform was made available to patients as part of an experiment conducted by Strasbourg University Hospital [33]. Between February 2014 and April 2015, 175 patients were given the chance to use the E-care platform [30]. 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. The mean age of these patients was 72 years and the ratio of men to women was 0.7. The patients suffered from multiple concomitant diseases and had a mean Charlson index of 4.1. The five main diseases were: Heart failure in more than 60% of the subjects, anemia in more than 40%, atrial fibrillation in 30%, type II diabetes in 30%, and chronic obstructive pulmonary disease in 30%. During the study, 1500 measurements were taken in these 175 patients, which resulted in the E-care system generating 700 alerts in 68 patients [33]. Some 107 subjects (61.1%) had no alerts during follow-up. Analysis of the follow-up of these 107 patients revealed that they had no clinically significant events that might eventually have led to hospitalization. Analysis of the warning alerts showed that the E-care platform automatically and non-intrusively detected any worsening of the patient's health, particularly cardiac decompensation. Indeed, it was in this last

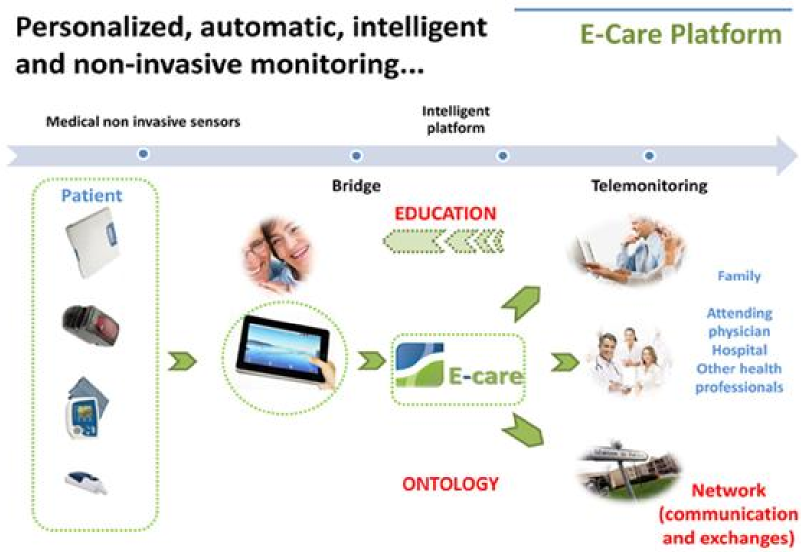

Fig. 1. Version 1 of the generic telemedicine platform developed in the E-care telemonitoring project in heart failure patients. This platform utilized nonintrusive medical sensors measuring blood pressure, heart rate, oxygen saturation and weight connected by Bluetooth and relaying real-time physiological data on the health status of the patient; touchscreen tablets connected by Wi-Fi or 3G/4G; and an Internet server hosting an inference engine that generated the warning alerts. These alerts indicated a deterioration in the patient's chronic diseases. Health professionals could access them via a secure Internet portal

setting that the system yielded the best sensitivity, specificity, and positive and negative predictive values, respectively 100%, 72%, 90% and 100%. The E-care platform also showed its ability to detect a deterioration in health status via the multiple diseases of the patients studied, with sensitivity, specificity, and positive and negative predictive values of, respectively 100%, 30%, 89% and 100%.

To our knowledge, the E-care project is the first to have been conducted in heart failure patients who were elderly (mean age of 72 years), who had multiple concomitant diseases, who belonged to the geriatric population (mean Charlson index of 4.1), and who were offered a telemedicine solution that enabled early detection of situations likely to progress to acute heart failure [30,31,33]. Here, we are entering the realm of predictive medicine, which, for the E-care platform, also aims to be personalized, that is, tailored to the phenotype of each patient. For practitioners, the result is that the E-care platform detected 100% of cardiac decompensations, and that in three quarters of cases, the alerts related to this setting. Only 10% of the alerts did not directly relate to heart failure. As far as we can tell, it is the first time that this kind of connected, smart system has been developed with the aid of tools from new technologies, prefiguring the solutions of telemedicine 2.0.

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. It is worth pointing out the tools and the system were tested and improved beforehand by patients and the personnel at CENTICH, the French research center on the use of ICT for promoting autonomy in the elderly. Hence, it has been our experience that age is not a limiting factor on grasping and using new technologies. Several recent studies have reached the same conclusion, documenting the use of telemedicine solutions even among 80-year-olds [34,35].

For practitioners interested in telemedicine, it is essential to highlight that the E-care telemonitoring solution is currently being assessed for the CE medical device mark (proving its excellent quality) rather than just the simple CE mark (like many tools currently on the market).

6. AVENUES FOR DEVELOPING THE E-CARE PLATFORM

As discussed above, the E-care platform appears to be capable of preventing hospitalization by detecting any deterioration in the patient's health status early and by making it possible for the care providers in charge of the patient to be warned and, above all, to intervene [30,31]. The platform is also 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 (Fig. 2) [32]. 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.

Over a period of several months, it will follow 100 patients with NYHA Stage-II to -IV heart failure using the PRADO organizational model for heart failure patients developed by the Bas-Rhin branch of the national health insurance [33]. For recruitment, the project will take advantage of the heart failure care pathway that includes the cardiologists, internists, emergency physicians and geriatricians of Strasbourg University Hospital [36]. Here, again, there will be no draconian selection of patients. Rather, they will be gradually enrolled so that they are representative of subjects with heart failure in France. In this care pathway, the mean age of patients that we are likely to enroll is 82 years [36]. The morbidity and mortality data of these 100 patients equipped with the telemedicine solution will be compared against the data of patients enrolled in the PRADO program and against the data of patients eligible for neither the PRADO INCADO project nor the PRADO program (the control group). The first heart failure patients are expected to be enrolled during the first quarter of 2018. The patients will come from the greater Strasbourg area. Besides its medical aims, PRADO INCADO will also comprise an economic aspect on cost analysis and an organizational aspect on patient pathways and on the uptake of the solution by patients and healthcare professionals.

The data derived from the PRADO INCADO project will be reinforced with data on the patient's environment and with the patient's profile (including prior history, medication, and adherence to treatment, diet and lifestyle guidelines, and use of the system itself). All this data combined should soon make the telemonitoring system even more effective [37,38]. This phase will allow us to conduct an in-depth study so as to improve diagnosis by aiding machine learning and, therefore, detect abnormalities early. This is in keeping with the research of Mortazavi and colleagues on the utility of artificial intelligence in managing heart failure patients, particularly the possibility afforded by artificial intelligence of predicting re-hospitalization for acute heart failure [39].

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.

To this end, new remote sensors and tailored questionnaires are being integrated into the E-care platform, including remote glucose meters, actometers and an electronic spirometer, along with new knowledge (in the form of ontologies) to enhance the platform and broaden its utility to other chronic diseases like diabetes and chronic obstructive pulmonary disease [40]. These diseases have a number of points in common with heart failure in terms of epidemiology and natural history. Like heart failure, diabetes and chronic obstructive pulmonary disease are among the most common diseases in developed countries and represent a public health problem for our societies [1]. Crucially, like heart failure, they are accompanied by frequent admissions and readmissions to hospital for well-known causes. These causal factors can be detected and prevented, thereby enabling healthcare professionals to act ahead of time, as in heart

Fig. 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

failure. Developing warning alerts for these chronic diseases should enrich the system. New tools including sensors and questionnaires are also being developed and/or validated to target the risks specific to elderly subjects, namely falls, confusion and malnutrition [40]. This is one of the major priorities in the success of telemedicine in the geriatric population, as is tailoring these tools to the physical and intellectual capacities of elderly subjects.

In the upcoming months, a new version of E-care will be tailored to telemonitoring 2.0 of elderly subjects and is expected to be distributed in 2018 among patients residing in the nursing homes of Rouen University Hospital, France [40]. It ought to be pointed out that, besides telemonitoring, many projects involving teleconsultation between practitioners or between patients and practitioners have already been deployed and are operational in several regions of France, such as the TELEGERIA project in geriatrics and the TELEHPAD project in Brittany facilitating access to care in rural areas [41,42].

7. CONCLUSIONS

Although many telemedicine projects have been conducted in the heart failure area, relatively few have been conducted in elderly subjects. In particular in France, new telemedicine 2.0 projects are being developed with the aid of ICT and the Internet. The E-care telemonitoring project is one that wholly falls under this category. Their potential utility in terms of morbidity, mortality and avoidance of hospital admissions is being studied or documented. Their impact in terms of health savings is also being assessed. Indeed, although the earliest telemedicine projects confirmed certain clinical benefits, they mostly demonstrated its economic benefits. As with E-care, the telemedicine 2.0 projects are perfectly compatible with the care pathways being developed in chronic diseases by the French health authorities (including the French ministry of health and the regional branch of the national health insurance). 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.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Available:http://invs.santepubliquefrance.fr/publications/etat_sante_2017/ESP2017_Ouvrage_complet_vdef.pdf [janvier 2018].
2. Available:http://www.has-sante.fr/portail/upload/docs/application/pdf/2012-04/guide parcours de soins ic web.pdf [Janvier 2018].
3. Jessup M, Brozena S. Heart failure. N Engl J Med. 2003;348:2007–18.
4. Anker SD, Koehler F, Abraham WT. Telemedicine and remote management of patients with heart failure. Lancet. 2011; 378:731–9.
5. Puricel SG, Ruiz J. Le diabète et l'ère de la télémédecine. Rev Med Suisse. 2014;10: 1246-8.
6. Rosen D, McCall JD, Primack BA. Telehealth protocol to prevent readmission among high-risk patients with congestive heart failure. Am J Med. 2017;130:1326-30.
7. Burdese E, Testa M, Raucci P, Ferreri C, Giovannini G, Lombardo E, et al. Usefulness of a telemedicine program in refractory older congestive heart failure patients. Diseases. 2018;6. DOI: 10.3390/diseases6010010
8. Feltner C, Jones CD, Cené CW, Zheng ZJ, Sueta CA, Coker-Schwimmer EJ, et al. Transitional care interventions to prevent readmissions for persons with heart failure: A systematic review and meta-analysis. Ann Intern Med. 2014;160:774–84.
9. Martínez-González NA, Berchtold P, Ullman K, Busato A, Egger M. Integrated care programmes for adults with chronic conditions: A meta-review. Int J Qual Health Care. 2014;26:561–70.
10. Achelrod D. Policy expectations and reality of telemedicine – a critical analysis of health care outcomes, costs and acceptance for congestive heart failure. J Telemed Telecare. 2014;20:192–200.
11. Pandor A, Thokala P, Gomersall T, Baalbaki H, Stevens JW, Wang J, et al. Home telemonitoring or structured telephone support programmes after recent discharge in patients with heart failure: systematic review and economic evaluation. Health Technol Assess. 2013; 17:1–207.
12. Kraai IH, Luttik ML, de Jong RM, Jaarsma T, Hillege HL. Heart failure patients monitored with telemedicine: Patient satisfaction, a review of the literature. J Card Fail. 2011;17:684–90.
13. Dendale P, De Keulenaer G, Troisfontaines P, Weytjens C, Mullens W, Elegeert I, et al. Effect of a telemonitoring-facilitated collaboration between general practitioner and heart failure clinic on mortality and rehospitalization rates in severe heart failure: The TEMA-HF 1 (TElemonitoring in the MAnagement of Heart Failure) study. Eur J Heart Fail. 2012;14:333–40.
14. Di Lenarda A, Caloso G, Gulizia MM, Aspromonte N, Scalvini S, Mortara A, et al. The future of telemedicine for the management of heart failure patients: A consensus document of the Italian association of hospital cardiologists (A.N.M.C.O), the Italian society of cardiology (S.I.C.) and the Italian society for telemedicine and health (Digital S.I.T.) Health Inform Res. 2015;21:223–9.
15. Available:http://www.thecochranelibrary.com/userfiles/ccoch/file/Telemedicine/CD007228.pdf [Janvier 2018]
16. Willemse E, Adriaenssens J, Dilles T, Remmen R. Do telemonitoring projects of heart failure fit the chronic care model? Int J Integr Care. 2014;14:e023.
17. Inglis SC, Clark RA, McAlister FA, Ball J, Lewinter C, Cullington D, Stewart S, et al.

Structured telephone support or telemonitoring programmes. Cochrane Database Syst Rev. 2010;8:CD007228.

18. Chaudhry SI, Mattera JA, Curtis JP, Spertus JA, Herrin J, Lin Z, Phillips CO, et al. Telemonitoring in patients with heart failure. N Engl J Med. 2010;363:2301–9.
19. Koehler F, Winkler S, Schieber M, Sechtem U, Stangl K, Böhm M, Boll H, et al. Impact of remote telemedical management on mortality and hospitalizations in ambulatory patients with chronic heart failure: The telemedical interventional monitoring in heart failure study. Circulation. 2011;123:1873–80.
20. Kitsiou S, Paré G, Jaana M. Systematic reviews and meta-analyses of home telemonitoring interventions for patients with chronic diseases: A critical assessment of their methodological quality. J Med Internet Res. 2013;15:e150.
21. Andrès E, Talha S, Hajjam M, Hajjam J, Ervé S, Hajjam A. E-care project: A promising e-plateform for the optimizing management of chronic heart failure and other chronic diseases. Heart Res Open J. 2015;1:39–45.
22. Scalvini S, Capomolla S, Zanelli E, Benigno M, Domenighini D, Paletta L, et al. Effect of home-based telecardiology on chronic heart failure: Costs and outcomes. J Telemed Telecare. 2005;11(Suppl 1):16-8.
23. Available:https://www.legifrance.gouv.fr/eli/arrete/2017/4/25/AFSH1711560A/jo/texte/fr
    [Janvier 2018]
24. Burdese E, Testa M, Raucci P, Ferreri C, Giovannini G, Lombardo E, Avogadri E, Feola M. Usefulness of a telemedicine program in refractory older congestive heart failure patients. Diseases. 2018; 6(10).
    DOI: 10.3390/diseases6010010
25. Kaladjurdjevic M, Antonicelli R. Evaluation of motivation and attitude for telehome-care among caregivers of elderly patients affected with congestive heart failure. Digital Medicine. 2016;2:149-56.
26. Available:http://www.telesante-basse-normandie.fr/l-enrs-et-les-projets/scad,1642, 1346.html
    [Janvier 2018]
27. Available:http://www.pimps.fr/
    [Janvier 2015]
28. Available:http://www.osicat.fr/
    [Janvier 2018]
29. Available:http://www.groupe.reunica.com/files/live/sites/reucorp/files/VousInformer/EspacePresse/Dossiers/DossierdepresseReunicaDomicile_Dispositifdetelemedecineadomicilepourinsuffisancecardiaquechronique.pdf
    [Août 2015]
30. Andrès E, Talha S, Ahmed Benyahia A, Keller O, Hajjam M, Moukadem A, et al. Expérimentation d'une plateforme de détection automatisée des situations à risque de décompensation cardiaque (plateforme E-care) dans une unité de Médecine Interne. Rev Med Interne. 2016; 37:587-93.
31. Andrès E, Talha S, Benyahia AA, Keller O, Hajjam M, Moukadem A, et al. e-Health: A promising solution for the optimized management of chronic diseases. Example of a national e-Health project E-care based on a e-plateform in the context of chronic heart failure. European Research in Telemedicine/La Recherche Européenne en Télémédecine. 2015;4:87-94.
32. Ahmed Benyahia A, Hajjam A, Talha S, Hajjam M, Andrès E, Hilaire V. E-care: Evolution ontologique et amélioration des connaissances pour le suivi des insuffisants cardiaques. Med Ther. 2014; 20:79–86.
33. Andrès E, Talha S, Hajjam M, Keller O, Hajjam J, Ervé S, HajjamA. Résultats de l'expérimentation d'une plateforme de détection automatisée des situations à risque de décompensation cardiaque (plateforme E-care) auprès de patients présentant des pathologies chroniques, suivis en médecine interne. Rev Med Interne: Accepté pour publication ; 2018.
34. Antonicelli R, Testarmata P, Spazzafumo L, Gagliardi C, Bilo G, Valentini M, et al. Impact of telemonitoring at home on the management of elderly patients with congestive heart failure. J Telemed Telecare. 2008;14:300-5.
35. Bashi N, Karunanithi M, Fatehi F, Ding H, Walters D. Remote monitoring of patients with heart failure: An overview of systematic reviews. J Med Internet Res. 2017;19:e18.
36. Andrès E, Talha S, Roul G, Bilbault P, Vogel T. Insuffisance cardiaque: Rôle des

internistes dans la mise en place d'une filière dédiée à la prise en charge de cette affection. Étude de preuve de concept sur 157 patients. Rev Med Interne. 2017; 38(S2):A92.
37. Ahmed Benyahia A, Hajjam A, Andrès E, Hajjam M, Hilaire V. Including other system in E-Care telemonitoring platform. Stud Health Technol Inform. 2013;190:115–7.
38. Elasri H, Sekkaki A, Hajjam A, Benmimoune L, Talha S, Andrès E. Ontologies et intégration des connaissances pour un suivi polypathologique. Med Ther. 2014;20:67–78.
39. Mortazavi BJ, Downing NS, Bucholz EM, Dharmarajan K, Manhapra A, Li SX, et al. Analysis of machine learning techniques for heart failure readmissions. Circ Cardiovasc Qual Outcomes. 2016;9:629-40.
40. Available:https://www.predimed-technology.fr/
41. Espinoza P, Gouaze A, Bonnet B, Fabbro M, Saint-Jean O, Mortelette X, et al. Déploiement de la télémédecine en territoire de santé. Télégéria, Un Modèle Expérimental Précurseur. TH. 2011;725:9-17.
42. Mathieu-Fritz A, Smadja D, Espinoza P, Esterle L. Télémédecine et gériatrie. La place du patient âgé dans le dispositif de consultations médicales à distance du réseau Télégéria. Gerontol Soc. 2012;141: 117.

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