Telehealth for patients with heart failure:
A comparison between telehealth systems

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Abstract: With the improvement of technology, home monitoring systems have become widely available at lower costs. As a consequence, the importance of telehealth systems has increased significantly over the last decade. Because of this, it is paramount to know how the efficiency of such systems can be improved. This study shows that the inclusion of educational material, and a user-friendly platform leads to significantly better compliance by the patients. Here, patients suffering from heart failure were studied, and two telehealth platforms were evaluated, namely Docobo and Philips.

Introduction

Heart failure (HF) is considered one of the most common diseases in Western Europe, with more than 10% of the people older than 75 year suffering from it. Furthermore, HF is recognized as a costly and disabling condition that threatens social and economical systems [1]. Therefore, the Recap (Regional Care Portals) project emerged as an initiative to develop innovative tools to promote and improve the implementation of telehealth systems [2]. This project involves transnational cooperation between thirteen partners from the North West Europe region that work towards the application of new financial, organizational, legal and technological solutions to the telemonitoring of HF patients. These new solutions aim to improve the diagnosis, therapy and remote monitoring of HF, by optimizing the communication between patients and care givers, and educating the patients to self-manage their condition. One of the partners involved in this project is the North East London NHS Foundation Trust (NELFT) in the

UK, which is in charge of the recruitment of patients into the telehealth study, and of the follow up of their condition. Currently, as a part of the Recap project, two telehealth platforms are being deployed to the patients, namely, the Docobo unit and the Motiva platform provided by Philips. Fig. 1. shows these two platforms, and their characteristics are listed in Table 1.

The main difference between these two platforms is the user interface, which in the case of Philips contains more educational material, and a more interactive environment that allows the patients to follow the evolution of their disease closely. The comparison between these two systems is part of the Recap project, and one of the goals is to identify if there are advantages of the education provided by Philips on the compliance of the patients in the telehealth system. In this paper, two populations are studied, one with Docobo system, and another one with the Motiva platform. The goal is to identify if the patients with the Philips system show any difference with respect to the population with Docobo units. This comparison will give some indications of the characteristics that a telehealth system should have.

Docobo system



Taken from www.docobo.co.uk

Motiva (Philips)



Taken from www.newscenter.philips.com

Fig. 1. Telehealth platforms used in the Recap project

Table 1. Characteristics of the telehealth platforms

Docobo	Philips
Stand-alone unit	Interactive telehealth platform
No video streaming	Personal healthcare channel
No educational information	Educational information to control and understand the condition
Blood pressure (systolic/diastolic)	Blood pressure (systolic/diastolic)
Pulse rate	Pulse rate
Oxygen saturation (SpO_2)	Oxygen saturation (SpO_2)
Body weight	Body weight

Methodology

Data

The dataset collected in this study consists of 212 HF patients (mean age 69 ± 12 years, 70 females, 142 males) referred to NELFT, and monitored in 2013. These patients were selected after evaluating the following inclusion and exclusion criteria.

Inclusion criteria: *a)* Older than 18 years, *b)* Valid diagnosis of LVSD (left ventricular systolic dysfunction) supported by a positive ECG, *c)* And must present any ONE of the following: Sudden increase in weight > 1.5kg in 24 hours; Blood Pressure < 90 systolic; Sudden increase in shortness of breath; Episodes of palpitation/tachycardia without collapse; Change of medication within 48 hours of discharge from acute; High Hospital Anxiety Depression Self Assessment (HADS) score.

If any of the following criteria applied, the patient was excluded from the study: Unconfirmed diagnosis (without ECG); Clinically stable – NYHA I to II classification (New York Heart Association); Patient is normotensive (120/80); Nil Oedema; Patient is end of life – NYHA > II; Insufficient cognitive understanding to use the telehealth equipment/complete questionnaires.

Once the patient was selected to be part of the study, one telehealth hub, either a Docobo or a Philips system, was randomly allocated. During the first days of the monitoring period, the patient was trained to measure twice a day, on a daily basis, 5 physiological parameters: blood pressure (systolic and diastolic), heart rate, oxygen saturation (SpO_2), and weight. After 42 days, the telehealth hub returned to NELFT, and it was allocated to a different patient.

Data analysis

In order to determine whether there is an influence of the system on the evolution of the patients, three different approaches were followed. First, linear regression was used to compute the slope of each physiological parameter. For this, the 42 days of measurement were used and each patient parameter was then characterized by the slope *m* (see Fig.2). The slopes of all patients were then compared. For the second and third approaches, the amount of times the patients measured themselves during the day, and the amount of missing data on each telehealth hub, were compared. All comparisons were evaluated using the Kruskal-Wallis test with a 95% confidence interval.

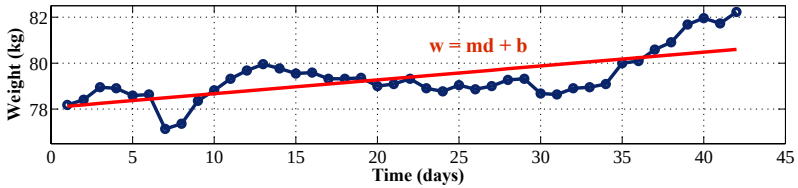

Fig. 2. Linear regression of the physiological parameters. Each parameter is characterized by the slope *m*. *w* represents the weight, *d* the day, and *b* the bias term.

Results and Discussion

After comparing the trends of each physiological parameter, using the slopes after linear regression, no significant differences were found between the telehealth systems. This is not a surprise, since the follow up of patients used in both systems was exactly the same. However, when looking at the amount of times the patients with the Philips system measured themselves in one day, significant differences ($p<0.05$) were found on all parameters. Patients with this system seem to comply much better with the telehealth study (see Fig. 3a). This can be explained by the fact that the interface offered by Philips is more user friendly and it offers educational videos and a more interactive environment. This can also be observed in the amount of days the patients with the Docobo system forgot, or did not use the system (see Fig. 3b). An important factor that needs to be taken into account in future studies is that patients seem to forget more often to take weight measurements, and this represents a big limitation, since it is one of the most informative parameters to predict HF [1].

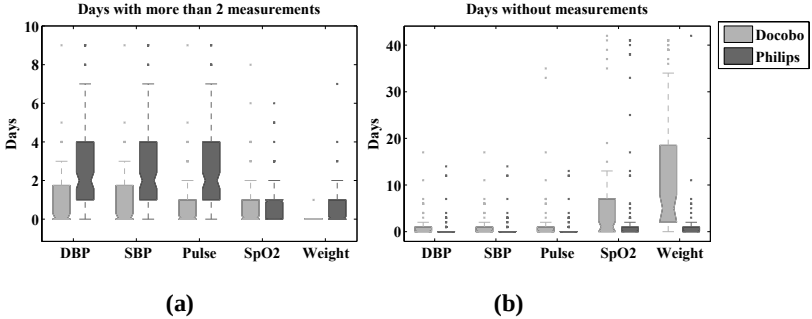

Fig. 3. Comparison between telehealth systems. Note that the patients with Philips system seem to comply significantly better ($p<<0.05$) than the patients with Docobo units. (a) Number of days when the patients measured themselves more than required. (b) Amount of days without any measurement.

Conclusions

Early observations indicate some differences between both systems, however further data will be analysed during the course of the project to further verify this. The fact that patients with Philips systems measure themselves significantly more times a day than patients with Docobo units seems to indicate that there is an apparent effect of the user friendliness provided by Philips. Patients with Philips technology may feel more comfortable with the system and comply much better than others, though equally clinicians are conscious that patients would not be encouraged to 'over monitor' i.e. take measurements more than the recommended times per day. As the project develops and more data is analysed, the findings can help telemonitoring projects like Recap to increase the benefits obtained by such systems, as patient compliance is an important aspect to any telehealth research.

The initial findings need to be confirmed with a quality of life questionnaire. Therefore, the European Heart Failure Self-Care Behaviour Scale questionnaire is currently implemented in the system, to be able to confirm the effect of education and user friendliness on telehealth.

Acknowledgments

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Authors’ Info



Carolina Varon received the degree in Electronic Engineering from the Universidad de Ibague Colombia in 2005, the Master degree in Astronomy and Astrophysics in 2009, and the Master degree in Artificial Intelligence in 2010, both from the KU Leuven, Belgium. She is currently working towards her Ph.D degree from the Department of Electrical Engineering (ESAT) of the KU Leuven. Her research interests include biomedical signal processing, decision support systems, machine learning, and optimization.



Jan Minter has over 30years of nursing and managerial experience within the NHS , currently working as part of North East London NHS Foundation Trust (NELFT) as a Cardiac Nurse Consultant, she has been instrumental in developing and redesigning Cardiac and Respiratory services, in order to ensure

they are ‘fit for purpose’. Jan is clinical lead for a range of specialist services made up of heart failure, COPD, epilepsy and parkinson’s, developing and implementing these services across the sub-economy, by encouraging innovative and new ways of working. Cardiology has long been a field of practice where the concept of innovation and change has been taken on board and Jan has used this influence to implement new concepts of care. Jan has some previous clinical experience of using Telehealth within the arena of Heart Failure, using this technology to provide quality care, and motivate both staff and patients to believe and be confident in the use of new technology.



Michelle Stapleton joined NHS South West Essex Community Services, now part of North East London NHS Foundation Trust (NELFT), in September 2008. Since joining the organisation she has welcomed the challenge of redesigning our community specialist services, in order to ensure they are ‘fit for purpose’. Michelle has more than 15 years experience of working in cancer and palliative care services as a senior nurse and manager and is currently the NELFT Integrated Care Director for Thurrock. Michelle is responsible for adult services, children's services, sexual health services and a wide range of specialist teams including end of life, COPD, heart failure and diabetes. Michelle proactively supports innovation and practice development and has successfully led her existing teams to be practice development units (PDU) since 2000.



Stuart Thomson joined Health Enterprise East (HEE), the NHS Innovation Hub, after completing his MSc in the Management of Intellectual Property at the Queen Mary, University of London. Stuart also holds a Diploma in European Intellectual Property, gained at the European Intellectual Property Institutes Network (EIPIN) and a BSC in Human Biosciences. As Head of Medical Technology for HEE, Stuart's primary responsibility is to manage the innovation portfolio and lead the innovation team to achieve successful protection, development and commercialisation of NHS Innovations covering medical devices, software, publications and training aids.



Siegfried Jaecques received a PhD in Materials Engineering from KU Leuven University in 1995. Until 2008 he did research on implant fixation and hard tissue restoration, [working in the Materials Engineering department, the division of Biomechanics and Engineering Design and the BIOMAT research cluster of the Dental School of KU Leuven]. From 2009 on, he coordinates the Leuven Medical Technology Centre (L-MTC), a research centre within K.U.Leuven, fostering inter-disciplinary research bridging the groups of Science & Technology and Biomedical Sciences. LMTC is also embedded within [K.U.Leuven Research & Development (LRD)], the technology transfer office of K.U.Leuven.



Sandra Sanders-van Wijk, received her MD degree in medicine from Maastricht University in 2010. She is currently finishing her PhD in the field of clinical biomarker and heart failure (HF) research and is a clinical resident in cardiology. She worked in the outpatient HF clinic of the Maastricht University Medical Centre for 4 years. Also, she received a Dutch National Presentation award in the field of HF in 2011 and is involved in several European research projects.



Hans-Peter Brunner-La Rocca is Professor of Cardiology, with special interest in clinical heart failure. He is currently working as vice chairman of the Department of Cardiology and Head of Heart Failure Clinic at the Maastricht University Medical Centre in the Netherlands. He did his training in Switzerland and was working as staff member and clinical researcher in Zurich and Basel. He has published more than 170 scientific papers. He has a special interest in personalized medicine, with focus on biomarkers in heart failure.



Sabine Van Huffel received the MD in computer science engineering in June 1981, the MD in Biomedical engineering in July 1985 and the Ph.D in electrical engineering in June 1987, all from KU Leuven, Belgium. She is full professor at the department of Electrical Engineering from the Katholieke Universiteit Leuven, Leuven, Belgium. In April 2013 she received an honorary doctorate from Eindhoven University of Technology, together with an appointment as a Distinguished professor from January 1, 2014 to January 1, 2018. She is heading the Biomedical Data Processing Research Group (BIOMED) within the Stadius Center for Dynamical Systems, Signal Processing and Data Analytics.