



Title	Conceptualising a Targeted Rehabilitation Exercise Biofeedback System for a Cancer Survivorship Population
Authors(s)	Brennan, Louise, Daly, Ailish, Caulfield, Brian
Publication date	2017-06-24
Publication information	Brennan, Louise, Ailish Daly, and Brian Caulfield. "Conceptualising a Targeted Rehabilitation Exercise Biofeedback System for a Cancer Survivorship Population." IEEE, 2017.
Conference details	The 30th IEEE International Symposium on Computer-Based Medical Systems (CBMS 2017), Thessaloniki, Greece, 22-24 June 2017.
Publisher	IEEE
Item record/more information	http://hdl.handle.net/10197/11631
Publisher's statement	© 2017 IEEE. Personal use of this material is permitted. Permission from IEEE must be obtained for all other uses, in any current or future media, including reprinting/republishing this material for advertising or promotional purposes, creating new collective works, for resale or redistribution to servers or lists, or reuse of any copyrighted component of this work in other works.
Publisher's version (DOI)	10.1109/CBMS.2017.104

Downloaded 2024-05-27 03:39:35

The UCD community has made this article openly available. Please share how this access benefits you. Your story matters! (@ucd_oa)



© Some rights reserved. For more information

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/321067970>

Conceptualising a Targeted Rehabilitation Exercise Biofeedback System for a Cancer Survivorship Population

Conference Paper · June 2017

DOI: 10.1109/CBMS.2017.104

CITATIONS

0

READS

68

3 authors, including:



Ailish Daly

UPMC Beacon Hospital, Dublin

5 PUBLICATIONS 61 CITATIONS

[SEE PROFILE](#)



Brian Caulfield

University College Dublin

345 PUBLICATIONS 6,428 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



Balance and Falls Risk Assessment [View project](#)



Kinesis QTUG [View project](#)

Conceptualising a Targeted Rehabilitation Exercise Biofeedback System for a Cancer Survivorship Population

Louise Brennan

Insight Centre for Data Analytics
University College Dublin,
Ireland.
Beacon Hospital, Dublin, Ireland.
louise.brennan@ucdconnect.ie

Ailish Daly

Allied Therapy Department
Beacon Hospital, Dublin, Ireland.
ailish.daly@beaconhospital.ie

Brian Caulfield

Insight Centre for Data Analytics
University College Dublin,
Ireland.
b.caulfield@ucd.ie

Keywords: Cancer Survivorship; Targeted Exercise; Biofeedback; Mobile Application.

I. INTRODUCTION

Over recent decades, improvements in the diagnosis and treatment of many types of cancer have meant that more individuals than ever before are surviving their initial diagnosis. In the Republic of Ireland, survival of all types of cancer has increased from 44.7% in 1994 to 59.9% in 2012. There are over 150,000 individuals living with and beyond cancer in Ireland in 2017 [1]. Some cancers are now classified as chronic diseases which require development of accessible, cost-effective rehabilitation strategies to reduce morbidity and disability, and maintain quality of life [2]. A mobile application using biofeedback to guide patients during their rehabilitation would be an innovative development in the field of cancer survivorship.

II. BACKGROUND

Individuals with a cancer diagnosis will often be referred to a physiotherapist for targeted exercises to rehabilitate impairments such as weakness, pain, incontinence, lymphoedema, and restricted joint movement [3-6]. Usually, the exercises are taught in a clinical setting by a physiotherapist and the patient is provided with information on continuing these exercises unsupervised at home. Poor adherence with exercises is associated with worse outcomes of treatment [7]. In up to 65% of cases, optimal adherence is limited by factors such as inability to remember correct exercise technique, low self-efficacy, and other physical, psychological and situational factors [8,9]. Living a long distance from a specialist oncology treatment centre, and concurrent chemotherapy or radiation therapy are additional cancer-specific barriers to treatment.

The rapidly-expanding field of connected health has shown promise in delivering interactive targeted-exercise rehabilitation programmes, which aim to improve the quality of exercise performed at home. The use of

wearable movement sensors during performance of targeted rehabilitation exercises can provide biofeedback and information regarding correct exercise technique [10]. These sensors can be cost-efficient and commonplace technology, such as the inertial movement units (IMU) found in most smart phones. Incorporating an element of gamification can improve motivational and behavioural outcomes [11]. Home-based rehabilitation can be cost-efficient and convenient for the patient [12]. Several rehabilitation systems based on the use of some of the above features have been developed, however there are designed for use in musculoskeletal or orthopaedic rehabilitation [13-15].

III. PROPOSAL

This project is part of Cancer: Activating Technology for Connected Health Innovative Training Network (CATCH ITN), and proposes to develop and evaluate the effectiveness of a biofeedback mobile application for cancer survivors who require a home-based targeted-exercise programme. The application would be used in conjunction with a physiotherapist, who would meet the patient at the start of their rehabilitation pathway, for a full assessment and demonstration of the application. Further face-to-face reviews by the physiotherapist would be scheduled on a regular basis, with the option to review at an earlier date if required. IMUs will analyse and classify movement as described in [16]. Errors in technique would be identified and highlighted to the user, providing suggestions for correcting technique. Adherence would be charted and enhanced by using the sensor to count repetitions and log exercise sessions. Gamification such as clear goals, feedback and rewards, could make the user experience more enjoyable and enhance intrinsic motivation to perform exercises. As holistic care is paramount in cancer rehabilitation, this exercise application could be conceived as one part of a more comprehensive cancer care application which could also monitor and promote other healthy behaviours in cancer survivors, such as physical activity and positive mental health strategies.

The application may be on a smart phone or tablet device. A focus on equality of access is important, as the demographics and computer-literacy of individuals with cancer are wide-ranging. The design would be intuitive, attractive and user-friendly, with minimal actions and time required to commence an exercise session. Navigating the different sections, such as 'Education' and 'Exercise Information', would be simple and instinctive. The movement sensor would be easy to apply, safe and not cumbersome for the wearer. The application would be validated against the gold standard of what is being measured. Clear, accurate and meaningful results and information would be provided. The storage of data would be secure, yet easy to access for those who require it. The primary goal of the above described application would be to improve outcomes in cancer rehabilitation, with secondary aims of improving accessibility to quality cancer care and reducing associated costs. This would be an innovative development in cancer rehabilitation, as few relevant evidence-based apps for this specialty exist, and none, to the author's knowledge, using IMUs to provide biofeedback.

IV. CONCLUSION

An online targeted-exercise biofeedback system for use in cancer rehabilitation could be beneficial for the growing numbers of individuals surviving cancer. Rehabilitation outcomes may be enhanced using biofeedback, remote communication with the physiotherapist and adherence-enhancing techniques. This development and efficacy of such a system will be explored as part of CATCH ITN.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement no. 722012

References

- [1] Irish Cancer Society (2016). *Cancer Statistics*. Available at: <https://www.cancer.ie/about-us/media-centre/cancer-statistics#sthash.MtKz8JFv.dpbs>. (Accessed 24 February 2017)
- [2] World Health Organization (2008) *2008-2013 action plan for the global strategy for the prevention and control of Noncommunicable diseases*. Available at: <http://www.who.int/nmh/Actionplan-PC-NCD-2008.pdf> (Accessed: 18 January 2017)
- [3] NICE (2016) *Early and locally advanced breast cancer - NICE pathways*. Available at: <https://pathways.nice.org.uk/pathways/early-and-locally-advanced-breast-cancer> (Accessed: 18 January 2017).
- [4] Bendz, I. and Fagevik Olsén, M. (2002) 'Evaluation of immediate versus delayed shoulder exercises after breast cancer surgery including lymph node dissection – A randomised controlled trial', *The Breast*, 11(3), pp. 241–248.
- [5] Chartered Society of Physiotherapists (2012) *Physiotherapy Works: Cancer Survivorship*. Available at: <https://CSP:http://www.csp.org.uk/publications/physiotherapy-works-cancer-survivorship> (Accessed: 18 January 2017).
- [6] De Groef, A., Van Kampen, M., Dieltjens, E., Christiaens, M.R., Neven, P., Geraerts, I. and Devoogdt, N. (2015) 'Effectiveness of Postoperative physical therapy for upper-limb Impairments after breast cancer treatment: A systematic review', *Archives of Physical Medicine and Rehabilitation*, 96(6), pp. 1140–1153.
- [7] Friedrich, M., Cermak, T., Maderbacher, P. (1996) 'The effect of brochure use versus therapist teaching on patients performing therapeutic exercise and on changes in impairment status.' *Physical Therapy* 76(10), pp. 1082–1088.
- [8] Jack, K., McLean, S.M., Moffett, J.K. and Gardiner, E. (2010) 'Barriers to treatment adherence in physiotherapy outpatient clinics: A systematic review', *Manual Therapy*, 15(3), pp. 220-228.
- [9] Bassett, SF (2003) 'The assessment of patient adherence to physiotherapy rehabilitation.' *NZ Journal of Physiotherapy* 31, pp.60-6.
- [10] Giggins, O.M., Sweeney, K.T. and Caulfield, B. (2014) 'Rehabilitation exercise assessment using inertial sensors: A cross-sectional analytical study', *Journal of NeuroEngineering and Rehabilitation*, 11(1), pp. 158-168.
- [11] Hamari, J., Koivisto, J., and Sarsa, H. (2014). Does Gamification Work? – A Literature Review of Empirical Studies on Gamification. In *proceedings of the 47th Hawaii International Conference on System Sciences*, Hawaii, USA, January 6-9, 2014.
- [12] Tousignant, M., Moffet, H., Nadeau, S., Mérette, C., Boissy, P., Corriveau, H., Marquis, F., Cabana, F., Ranger, P., Belzile, É.L. and Dimentberg, R. (2015) 'Cost analysis of in-home Telerehabilitation for post-knee Arthroplasty', *Journal of Medical Internet Research*, 17(3), p. e83.
- [13] Brutovsky, J. and Novak, D. (2006) Low-cost motivated rehabilitation system for post-operation exercises. *Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, EMBC, New York, USA.
- [14] Chen, K.H., Chen, P.C., Liu, K.C. and Chan, C.T. (2015) 'Wearable sensor-based rehabilitation exercise assessment for knee osteoarthritis', *Sensors*, 15(2), pp. 4193–4211
- [15] Piqueras, M., Marco, E., Coll, M., Escalada, F., Ballester, A., Cinca, C., Belmonte, R. and Muniesa, JM. (2013) 'Effectiveness of an interactive virtual telerehabilitation system in patients after total knee arthroplasty: a randomized controlled trial', *Journal of Rehabilitation Medicine*, 45(4), pp 392-6.
- [16] Huang, B., Giggins, O., Kechadi, M., Caulfield, B. (2016) 'The limb movement analysis of rehabilitation exercises using wearable inertial sensors', paper presented to 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Florida, August 2016.