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Conference Paper · June 2017

DOI: 10.1109/CBMS.2017.104

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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 Sklodowska-Curie grant agreement no. 722012

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