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stroke survivor

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Remote rehabilitation training using the combination of an exergame and telerehabilitation application: A case report of an elderly chronic stroke survivor

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Abstract— Access to remote rehabilitation services is now possible thanks to advanced technology solutions such as exergames and telerehabilitation-applications. This pretest/posttest single case study, conducted with one participant with a chronic stroke (3 years) aimed at collecting preliminary evidence regarding feasibility and efficacy of using a telerehabilitation application combined with an exergame on upper limb function, motivation and quality of life after stroke. Forty-two exergame training sessions (including 8 videoconferencing sessions) took place over a two-month period. The results showed significant improvement of upper limb motor function and an increase of the affected upper limb amount of use in activities of daily life. However, no significant change was recorded regarding the impact on quality of life and motivation. These preliminary results allow us to have a first glimpse of the potential of this program and better inform a larger scale study.

Keywords— *Telerehabilitation, exergame, upper-limb, stroke*

I. INTRODUCTION

Patients with stroke have difficulty accessing external conventional rehabilitation services for a variety of reasons, including fatigue, lack of services and distance to travel[1]. Telerehabilitation combined with exergames provides a new approach that may counter the accessibility problems and optimize motor recovery of the upper limb, even in the chronic phase post-stroke. The objectives of this study were: 1/ to determine the feasibility of using a telerehabilitation application combined with an exergame 2/ to collect preliminary efficacy data of such a remote rehabilitation service on upper limb function, motivation and quality of life in a chronic stroke survivor.

II. METHODOLOGY

A. Study design and intervention

This is a pretest/posttest single case study design of a 63-year-old male stroke survivor (3 years) who does not live in the same city as the research team. This case study was developed in the context of a larger study prior to starting a randomized clinical trial to contribute to developing the evaluation and intervention protocols. The participant was invited to complete the remote rehabilitation program for two months using a telerehabilitation application combined with a virtual reality game. The program included 5 sessions (30 minutes) of upper limb exergame training (20 hours in total

over 2 months) and one videoconferencing session (1 hour) with a clinician per week. We used the Jintronix©-exergame which includes 6 types of upper limb exercises with different levels of difficulty (number of rounds, repetition, time, speed, precision and shape of objects). The exercises were chosen and adjusted remotely by the clinician, based on the participant's preferences. For the telerehabilitation-application, we used Reacts©, which allows videoconferencing and secure sharing of participant's health information, for assessment, remote supervision and rehabilitation purposes.

B. Outcomes measures

Descriptive data concerning the intervention (number of sessions, duration) were documented in a standardized form at the end of each week. Progress was assessed remotely at baseline, at the end of two-month intervention and after a one- and two-month follow-up period, using the Fugl-Meyer Upper Extremity Assessment (FM-UEA)[2] as a primary outcome. Since the intervention could also affect upper limb function, motivation and participant quality of life, we also included secondary measures, self-reported questionnaires, such as the Motor Activity Log (MAL)[3], the Stroke Impact Scale-16 (SIS)[4] and the Treatment Self-Regulation Questionnaire-15 (TSRQ)[5]. All evaluations were conducted remotely, so we could only measure the motor function component of the FM-UEA. The motor function score was adjusted to 60 as we removed the reflex activity part from the total score of 66.

III. CONCEPTUAL FRAMEWORK

We used the self-determination theory[6] as a conceptual framework to guide the intervention in order to empower the participant and solicit his interest and motivation for the treatment plan that we propose in our intervention. Through the combination of the telearehabilitation system (Reacts©) and the Jintronix© gaming system, we aimed to foster patient-clinician interaction throughout the rehabilitation program, and to develop a partnership relationship based on information sharing and trust. It is in this perspective that the self-determination theory was integrated, its constructs helped us develop a discussion plan which the clinician refers to during videoconferenced meetings. This theory states that humans naturally tend to achieve changes that respect and enable the

satisfaction of their three basic psychological needs, namely: 1) autonomy, 2) connectivity and 3) competence[6]. There are two regulation processes predicting behavioral engagement and maintenance: the behavior emanating from intrinsic motivation and the internalization of extrinsic motivation[6]. These regulation processes were targeted in the form of subscales in the TSRQ [5]. The use of this questionnaire allowed us to investigate the impact that the motivation could have had on adherence to the program and its effectiveness.

IV. RESULTS

The participant completed 42 sessions of 29 hours active game, over a two-month period. The data collected presented here are those that were collected at the end of the intervention. The follow-up data has not yet been collected as the study is ongoing. The FM-UEA scores exhibited a significant increase in motor function component from 49 to 55 (mean score difference = 6) at the total score of 60, which is within the estimated clinically important difference ranges of 4.25 to 7.25[7]. The MAL showed a change in mean score of 0.88 and 0.95, in both the how well scale and amount scale respectively. The change in how well scale (mean score difference = 0.88) is not clinically meaningful (estimated clinically important difference is between 1.0 and 1.1[3]). The amount scale of MAL increased up to 2.45, close to the score of 2.5 predicting 50% or greater recovery[8]. The SIS showed no difference in scores between before and after the intervention. The TSRQ showed no difference in the scores of the subscales such as autonomous motivation, introjected regulation and amotivation. However, the external regulation subscale showed an increase in the scores from 6 to 10.

V. DISCUSSION

The data collected to date answers part of our objective which was to collect feasibility data regarding using a telerehabilitation application combined with an exergame for remote upper limb training in a chronic stroke survivor. The participant adhered completely to the program, completing 29 hours of active sitting game instead of 20 hours as prefixed to the program. A minimum of 15 hours is suggested for an intervention to result in a moderate improvement in activities related to daily living following a stroke [9]. No adverse events occurred during the first weeks of intervention. However, the patient reported an increased feeling of heaviness in the affected upper limb during the 4th week. The clinician in charge suggested stretching postures to the participant that he could apply at the beginning and the end of the games to prevent any discomfort. These were demonstrated during the videoconferenced sessions and relieved the discomfort.

The FM-UEA scores showed a significant clinical change in motor function component, suggesting that the Jintronix© exergames could affect upper limb motor recovery after stroke, even in chronic phase. The MAL amount subscale has also recorded an increase in the mean score from 1.5 to 2.45. However no meaningful difference was observed in the how well subscale and neither in the SIS. This suggests that training with a telerehabilitation system combined with an exergame

could improve motor recovery after stroke and increase the affected upper limb amount of use in activities of daily life but may not significantly affect the quality of the movement occurring during activities. At the motivational level, the TSRQ showed an increase in the external regulation subscale score which could positively impact on health behaviors and explain the change in the amount of use of the affected arm in activities of daily life. However, external regulation usually leads to short-term changes because the person's choices are under the control of certain consequences (I want others to approve of me) [5] and are not a consequence of their own desires (I feel pressure from others to do so)[5]. The follow-up data, as well as data from the larger randomized clinical trial will allow us to better understand the behavioral facets on which this intervention acts and whether the motor function changes lead to long-term recovery (after 2 months).

To sum up, these preliminary results allowed us to have a first glimpse of the potential of this program, however we must be cautious in our interpretations. First, our primary scale the FM-UEA was administered remotely and the validity of this outcome measure when used remotely has not yet been studied. In addition, the results of the larger randomized clinical trial on which this study is based, will allow us to confirm our findings.

CONCLUSION

The combination of the Jintronix© and Reacts©-applications could provide an effective therapeutic alternative for chronic stroke survivors. Other telerehabilitation systems and exergames may produce similar results, as long as they are combined. The study results gave us a first glimpse into the factors impacting on the effectiveness of such an approach.

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