Ghostly, an electromyography-based serious game to counter muscle mass and strength loss in hospitalized older adults

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Purpose The functional decline experienced by older adults and its interaction with morbidities expose them to an increased vulnerability to stressors (i.e., frailty) and higher risk of hospitalization. Additionally, hospitalization itself also poses risks for functional decline because of the negative effects of prolonged bedrest and restrictions in activity. This bedrest and restriction in activity leads to significant decline in several functional parameters and multiple muscle characteristics (e.g., muscle mass, muscle strength, etc.). Furthermore, strategies to mitigate these effects include targeted physical activity interventions, but these patients are often unable to perform dynamic, more high load functional exercises, further limiting recovery. With this in mind, the implementation of low load blood flow restriction training, in which the blood flow towards the targeted muscle is partially restricted during training, shows promising results. This novel training modality is proven to have beneficial effects on muscle mass and muscle strength compared to regular low load strength training. Moreover, serious games might provide a relevant solution to bridge the gap between exercise in bed and more functional out-of-bed exercises. Based on the principles of user-centered design, the Ghostly game, an electromyography-based serious game was developed as part of a co-creation process between engineers, clinicians and different patient populations. This feasibility study collected relevant data on usability and user experience from hospitalized older adults which in turn will be used to further develop the game and structure future larger randomized pilot studies. **Method** Patients were recruited from the geriatric ward of the University Hospital of Brussels and randomized in three groups. All groups received daily conventional therapy provided by the physiotherapist of the ward, as well as different forms of additional therapy based on group allocation. The Ghostly group received the Ghostly game as additional therapy, the Ghostly and blood flow restriction group received the Ghostly game combined with blood flow restriction therapy, and lastly, the control group received dose-matched isometric exercises. User experience and usability was assessed through observations by several different professionals (e.g., researchers, engineers, clinicians, etc.) while the patients were playing the Ghostly game, as well as after one week of intervention using the Usability, Satisfaction and Ease-of-use (USE) questionnaire. Furthermore, clinical outcomes (muscle strength, muscle architecture, segmental body composition, etc.) were measured at baseline and after one week of intervention in preparation of future larger randomized pilot studies. **Results and Discussion** In total 14 patients, ranging from 78 to 94 years old (mean age 84.93±4.43 years), were included in this study. On average participants completed 3 to 5 (mean 3.5±0.73) sessions before being discharged from the hospital. Observations from several professionals while the participants were playing the Ghostly game revealed several facilitators and barriers in usability related to in-game elements (color contrast, reaction speed, respawn checkpoints, etc.) that require adjustments to increase user experience. Nonetheless, the results from the USE questionnaire revealed an overall moderate to high score with regard to usefulness (71.96%), ease of use (74.94%), ease of learning (75.36%) and satisfaction (78.98%). These results further emphasize the need for a user-centered approach not only focusing on user experience data from a patient population, but also observational and qualitative data from professionals involved in the use and development of rehabilitation technology. Additionally, the results indicate that the current research protocol is feasible for future larger randomized controlled trials (RCT) in terms of recruitment, outcome measure assessments, duration of intervention, etc. Finally, the results from the clinical outcomes will be used to calculate sample size for the fully powered RCT to test the effectiveness of the Ghostly game in relation to strength training.