Basic Research/Poster

Assessing the Functionality of a Portable Rehabilitation System Used for Self-Management of Upper Extremity Function by Individuals With Stroke

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A functional portable rehabilitation system using a smartphone app and 3D-printed household items was developed, and data were collected to refine the system. This system can be used remotely to enable individuals with stroke to self-monitor their upper extremity performance.

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BACKGROUND AND PURPOSE: Stroke, the fifth leading cause of death in the United States (Benjamin et al., 2017), is a major cause of long-term disability leading to restriction in clients' occupational performance. A task-oriented approach is built on motor learning and motor control principles and is functional and client-centered. The task-oriented approach includes motor training, variable practice, and feedback on performance, leading to increases in clients' activity participation (Winstein et al., 2016). Smart technology use in rehabilitation is growing and can be used remotely to assist clients in self-monitoring their performance. With written home exercise programs being the commonly prescribed form of rehabilitation after discharge, mHealth coupled with task-oriented programs can enhance self-management of upper extremity training.

In the current study, a functional rehabilitation system was designed that included a smartphone app and 3D-printed household items such as a mug, bowl, key, and doorknob embedded with a smartphone. The app interface allows the user to select activities and record data for repetitions, time to complete the activity, and quality of movement. The app was also designed to provide feedback including time and smoothness of movement so users can self-monitor their performance.

The aim of the current study was twofold. First, we aimed to validate the accuracy of the app in counting repetitions and correctly identifying differences in movement between people with and without stroke. Second, we aimed to refine the rehabilitation system through user feedback on the 3D-printed objects and the app's user interface.

METHOD: For this pilot study, a combination of visual assessment, recorded kinematic data, and interviews was used to assess the rehabilitation system. Convenience sampling was used to recruit 12 participants, including four young adults aged 18–30, four older adults aged 60 or older, and four people with stroke.

The app was shown to each participant, who then completed a set of tasks with the household items, such as lifting and placing the mug on a shelf, walking with the bowl, and manipulating the key or the doorknob. The participants also used the app to set up their own exercise. Visual assessment of activities and kinematic performance data were collected. Interviews were then conducted to obtain feedback on the usability of the rehabilitation system and perception of future use of the system.

RESULTS: Participants reported that they felt comfortable using the interface of the app. They liked that the household items were 3D printed and would allow customization of the physical design (e.g., handle or lid of the mug) on the basis of user preference. Specific comments included the following: "I really like the audio and visual feedback on the phone screen." "The app is very simple to use." "I like that I can see how I can increase or decrease my score." The participants also made recommendations regarding the physical design and setup of the key and doorknob so they would better resemble real-life performance. Although the app missed some movements with initial participants, continued refinements led to accurate and consistent identification of movements by the app. Kinematic recordings distinguished the performance of participants with and without stroke.

CONCLUSION: The findings of this study indicate that the smartphone app accurately identified movements. Participant feedback allowed further refinement of the physical design of the 3D items and the app's user interface.

IMPACT STATEMENT: The refined version of the portable rehabilitation system can allow occupational therapy practitioners and other rehabilitation workers to help clients with stroke self-monitor their functional performance remotely.

References

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