A Prospective Case Series Evaluating the Effectiveness of a Virtual Reality Therapy Home-Based System to Improve Hand Usage and Function in Children with Hemiplegia

Bloorview KIDS REHAB

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Background

Hemiplegia:

• Impaired motor control and neglect on one side of body.

Virtual Reality (VR):

• Simulation of a real world environment using computer software.

• VR therapy is being evaluated in adults and children who have hemiplegia to decrease neglect and improve motor function.

Current VR Literature

• Institution based VR therapy can enhance motor learning in adults with strokes [1].

• A small study on children with hemiplegic CP showed improved movement kinematics after using an institution based VR system [2].

Our IDEA

• Develop an inexpensive home-based VR therapy system that can only be played with the hemiplegic hand and requires minimal parental supervision.

Bloorview Kids Rehab's Virtual Reality System

• A novel VR system that "forces" the use of the hemiplegic hand by constraining the non-hemiplegic hand. It was designed to be inexpensive and easy to integrate into a home environment.

Play Station 2 (PS2) with Eye-Toy

• Home based system with attached camera. Child can see themselves on the screen and play games by moving their hemiplegic arm.

• Utilized 2 commercial collections of mini-games designed for children to use with the Eye-Toy.

Engineered Chair

• Two buttons were incorporated to facilitate the use of the hemiplegic arm. When both buttons are pressed, the games are activated.

  • One button, underneath the seat, is pressed by the dominant hand, forcing the child to play with their hemiplegic arm.

  • Another button, on the back of the chair, ensured that the child extended their hemiplegic arm rather than flex their trunk to play.

Objectives

Objective 1:

To determine the effectiveness of the home based VR therapy system to improve hemiplegic upper extremity use and function in children with hemiplegia CP.

Objective 2:

To conduct a usability assessment of the developed VR system.

Methods

Study Design: Prospective case series

Inclusion Criteria: Children (5-10 years old) with hemiplegic CP

Intervention

- VR system installed in home
- Child to play on VR system for 0.5 h/day for 2 months

Outcome Measures (baseline and 2 months)

Primary: Assisting Hand Assessment (AHA)
(Measures use of hemiplegic hand in bilateral tasks [3])

Secondary: Pediatric Motor Activity Log (PMAL)
Quality of Upper Extremity Skills (QUEST)
Pediatric Evaluation of Disability Inventory (PEDI)
Canadian Occupational Performance Measure (COPM)
Grip strength

- Measures to assess usability of the VRT system:
  - Computer usage log of when child played on the system
  - Parent/child qualitative questionnaire

Statistical Analyses

- Paired t-tests or Wilcoxon Signed Rank tests. Statistical significance was adjusted ($p<0.006$) using the Bonferroni correction for secondary measures.
- Correlation between change in AHA with duration of VRT playtime.

Results

• 15 children with hemiplegia (mean age 8.8 years ± 2.3)

• Objective 1

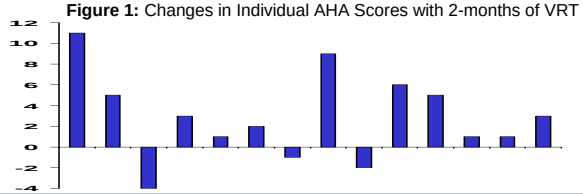
Table 1: Outcome Measure Results

Measure	Baseline (mean ± SD)	2 months (mean ± SD)	Statistical Test & P-value
AHA	55.5 ± 11.77	58.4± 10.96	Z(w)=2.23, p=0.03*
QUEST (Grasp Score)	36.30 ± 21.52	36.69± 25.12	t= 0.13, p=0.90
PEDI (Functional Self Care Skills)	74.4± 12.35	76.3 ± 13.04	t=1.77, p=0.10
PEDI (Caregiver Assistance)	79.1± 13.78	83.5± 16.14	t=2.23, p=0.04
COPM (Performance)	4.0 ± 1.50	5.0 ± 1.68	Z(w)=2.64, p=0.008
COPM (Satisfaction)	4.5± 1.96	5.3 ± 1.92	Z(w)=1.72, p=0.08
PMAL (How Often)	1.7 ± 0.85	2.0 ± 0.73	Z(w)=1.19, p=0.23
PMAL (How Well)	2.5 ± 0.92	2.5± 0.83	Z(w)=-0.22, p=0.83
Grip Strength	79.7± 20.31	81.3 ± 23.25	t=0.57, p=0.58

* Indicates statistical significance ($p<0.05$)

• There was no significant relationship between change in AHA score and total time played ($r= -0.187$, $p=0.521$).

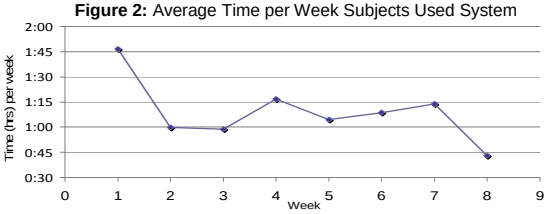
Figure 1: Changes in Individual AHA Scores with 2-months of VRT



Objective 2

- Children enjoyed system, but overtime had decreased interest.
- Average daily usage was 0.16 h (or 9.6 minutes)/day (SD=0.11) which decreased over 8 weeks.

Figure 2: Average Time per Week Subjects Used System



Reported reasons for low usage included:
- Boredom due to simplistic games and a lack of game variety.
- Frustration when games would stop after a momentary button release.

Discussion

VR Effectiveness (Objective 1)

• After 2-months of home-based VR therapy, a mean change of 2.9 points on the AHA was found reflecting a small clinical and statistically significant improvement in bilateral hand use. [3]).

• No statistically significant improvements in any secondary measures were found, perhaps due to short VR playing time.

VR Usability (Objective 2)

• Children & parents enjoyed the concept of a home based system

• Decreasing child frustration (re-engineer button release time) and boredom (enhance game variety) will be essential prior to further study of the VR system

Recommendations & Next Steps

• Resolve obstacles related to low system usage including:

Stoppage of game due to temporary button release: Future models should include a warning when a button is released, allowing several seconds before the game stops.

Lack of game variety and complexity: Increasing game variety may require a more current platform (eg: internet-based games). Also a digital video camera (eg: webcam) could capture movement.

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• The children and families who participated in this research

References

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3) Krumlinde Sundholm L, Holmefur M, Eliasson AC. Manual: Assisting Hand Assessment. English Research Version 4.4. Stockholm; 2007