Virtual or Augmented Reality for Pediatric Rehabilitation: Clinical Effectiveness
Research Question
What is the clinical effectiveness of virtual or augmented reality in pediatric rehabilitation?

Key Findings
Five systematic reviews (one with meta-analysis), four randomized controlled trials, and two non-randomized studies regarding the effectiveness of virtual reality (VR) interventions for children who require rehabilitation were identified.

Methods
A limited literature search was conducted on key resources including PubMed, The Cochrane Library, University of York Centre for Reviews and Dissemination (CRD) databases, PEDro, Canadian and major international health technology agencies, as well as a focused Internet search. No filters were applied to limit the retrieval by study type. Where possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2013 and February 7, 2018. Internet links were provided, where available.

Selection Criteria
One reviewer screened citations and selected studies based on the inclusion criteria presented in Table 1.

<table>
<thead>
<tr>
<th>Table 1: Selection Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Population</strong></td>
</tr>
<tr>
<td><strong>Intervention</strong></td>
</tr>
<tr>
<td><strong>Comparators</strong></td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
</tr>
<tr>
<td><strong>Study Designs</strong></td>
</tr>
</tbody>
</table>
Results

Rapid Response reports are organized so that the higher quality evidence is presented first. Therefore, health technology assessment reports, systematic reviews, and meta-analyses are presented first. These are followed by randomized controlled trials, and non-randomized studies.

Five systematic reviews (one with meta-analysis), four randomized controlled trials, and two non-randomized studies regarding the effectiveness of virtual reality (VR) interventions for children who require rehabilitation were identified. No health technology assessments were identified.

Additional references of potential interest are provided in the appendix.

Overall Summary of Findings

Five systematic reviews (SR),1-5 four randomized controlled trials (RCT),6-9 and two non-randomized studies10-11 regarding the effectiveness of virtual reality (VR) interventions for children who require rehabilitation were identified. Study details are included in Table 2.

Overall, in children with cerebral palsy, VR interventions were found to:
• Improve motor function1-2 (SR evidence)
• Be a ‘promising’ intervention to improve balance3,8 and motor development3,8 (SR, RCT evidence)
• Likely be effective in improving upper extremity function5-6 (SR, RCT evidence)
• May be valuable for improving reaction time7 (RCT evidence)
• Improve gait8,10 (RCT, NRS evidence)
• Increase endurance on walk tests8 (RCT evidence)
• Increase muscle strength8 (RCT evidence)
• Improve hand-eye coordination and visual motor speed9 (RCT evidence)

In children with acquired brain injuries, VR interventions were found to:
• Have potential both at home and in a clinical setting4 (SR evidence)
• Improve walking ability11 (NRS evidence)

Although 11 studies were identified, the authors of two systematic reviews3,5 expressed the need for further research in the abstracts.

Table 2: Summary of Included Studies on the Clinical Effectiveness of Virtual or Augmented Reality Interventions for Pediatric Patients

<table>
<thead>
<tr>
<th>First Author, Year</th>
<th>Study Objectives, Relevant Characteristics</th>
<th>Population, Setting</th>
<th>Intervention, Comparator</th>
<th>Results, Author Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chen, 2018’</td>
<td>To examine the effectiveness of VR</td>
<td>Children with cerebral palsy</td>
<td>Virtual reality (detail NR)</td>
<td>• Effect size of VR vs. other interventions was d = 0.861</td>
</tr>
</tbody>
</table>
### Table 2: Summary of Included Studies on the Clinical Effectiveness of Virtual or Augmented Reality Interventions for Pediatric Patients

<table>
<thead>
<tr>
<th>First Author, Year</th>
<th>Study Objectives, Relevant Characteristics</th>
<th>Population, Setting</th>
<th>Intervention, Comparator</th>
<th>Results, Author Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clutterbuck, 2018²</td>
<td>To evaluate active exercise interventions for improving gross motor function</td>
<td>School-aged children with CP who were ambulant or semi-ambulant</td>
<td>Exercise Interventions (including virtual reality)</td>
<td>Weak, positive evidence (evidence level II-V) indicated that non-immersive VR improved gross motor function</td>
</tr>
<tr>
<td>Ravi, 2017³</td>
<td>To update a SR; examine evidence regarding VR with respect to sensory and functional motor skills</td>
<td>Children and adolescents with CP N=369 children</td>
<td>VR rehabilitation (no details provided)</td>
<td>“Moderate” evidence regarding balance and overall motor development; limited evidence for other motor skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>VR rehabilitation described as a ‘promising’ intervention with respect to improving motor development and balance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Authors suggest long-term follow-up and further research</td>
</tr>
<tr>
<td>Baque, 2016⁴</td>
<td>To review the efficacy of physiotherapy interventions for improving gross motor capacity, performance, societal participation</td>
<td>Children aged 5 to 17 with acquired brain injury N=56 patients</td>
<td>VR interventions (no detail included)</td>
<td>All 4 VR studies provided level 4 evidence supporting VR intervention</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>VR therapies are potential treatment options in both the home and clinical settings</td>
</tr>
</tbody>
</table>
Table 2: Summary of Included Studies on the Clinical Effectiveness of Virtual or Augmented Reality Interventions for Pediatric Patients

<table>
<thead>
<tr>
<th>First Author, Year</th>
<th>Study Objectives, Relevant Characteristics</th>
<th>Population, Setting</th>
<th>Intervention, Comparator</th>
<th>Results, Author Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chen, 2014°</td>
<td>To review the effectiveness of VR interventions on upper extremity function</td>
<td>Children with CP N = NR</td>
<td>VR interventions (no detail provided)</td>
<td>Effect size was ‘strong’ ((d = 1.00)) for VR when pre and post time periods were compared. ‘Better’ improvement was seen for younger children who received VR treatment using engineer-built systems either at home or in a laboratory. VR can like be used to improve upper extremity function in children with CP; high quality trials are necessary to make strong recommendations.</td>
</tr>
<tr>
<td>El-Shamy, 2017°</td>
<td>Compare outcomes between VR and PT for the improvement in upper extremity function</td>
<td>Children with obstetric brachial plexus injury/Erb’s palsy N = 30</td>
<td>VR program using Armeo spring (12 weeks of therapy, 3 times a week for 45 minutes)</td>
<td>Conventional physiotherapy program (no detail provided)</td>
</tr>
<tr>
<td>Pourazar, 2017°</td>
<td>To examine the training effects of a VR intervention on reaction time MANOVA and paired sample t-tests used to perform analysis</td>
<td>Children with CP N= 30 100% male Age 7 to 12 years (mean = 11.20; SD = .76)</td>
<td>VR intervention (no detail provided) Control intervention (no detail provided)</td>
<td>Simple reactive time and discriminative reaction time significantly improved following VR intervention. VR may be a valuable tool for improving reaction time in children with CP.</td>
</tr>
<tr>
<td>Cho, 2016°</td>
<td>To investigate the effects of a VR treadmill intervention on gait, balance, muscular strength, and gross motor function</td>
<td>Children with spastic CP N = 18 (9 in VR group, mean age 10.2 years; 9 in no VR group, mean age 9.4 years)</td>
<td>Treadmill training with VR Treadmill training without VR Both groups also attended conventional physiotherapy 3 times a week for 8 weeks</td>
<td>After the intervention: Gait and balance were improved in the VR group when compared with the no VR group ((P &lt; 0.05)). Muscular strength, with the exception of right hamstring, was significantly greater in the VR group. VR group children had significantly greater improvements in gross motor function measure and...</td>
</tr>
</tbody>
</table>
### Table 2: Summary of Included Studies on the Clinical Effectiveness of Virtual or Augmented Reality Interventions for Pediatric Patients

<table>
<thead>
<tr>
<th>First Author, Year</th>
<th>Study Objectives, Relevant Characteristics</th>
<th>Population, Setting</th>
<th>Intervention, Comparator</th>
<th>Results, Author Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shin, 2015\textsuperscript{\textdagger}</td>
<td>Compare the effects of conventional neurological treatment with a VR intervention on hand-eye coordination</td>
<td>Children with spastic diplegic CP N = 19 (9 boys, 7 girls; 8 randomly assigned to each treatment group)</td>
<td>VR training (30 minutes of therapeutic exercises, 15 minutes of VR training, 2 times per week) Conventional neurological therapy (45 minutes of therapeutic exercises, 2 times per week)</td>
<td>After 8 weeks: • Eye-hand coordination and visual motor speed were significantly different between the two groups • Authors concluded that a ‘well-designed’ program that includes VR could improve hand-eye coordination and visual motor speed</td>
</tr>
<tr>
<td>van Gelder, 2017\textsuperscript{\textdaggerdbl}</td>
<td>To examine of children with CP can adapt gait in response to real-time feedback</td>
<td>Ambulatory children with CP N = 16 Ages 6 to 16</td>
<td>Walking on a treadmill with VR with: regular walking without feedback, feedback on hip angle, and feedback on knee angle</td>
<td>• 15 of 16 children had improvements in during gait in response to feedback; 9 achieved clinically relevant improvements • Those who responded to feedback had worse initial gait (P = 0.005) and functional selectivity score (P = 0.049)</td>
</tr>
<tr>
<td>Biffi, 2017\textsuperscript{\textdaggerdbl}</td>
<td>To evaluate the efficacy of a VR rehabilitation system to enhance walking ability</td>
<td>Children with acquired brain injury N = 12 Mean age 12.1; SD 3.8</td>
<td>Gait Real-time Analysis Interactive Lab (GRAIL) immersive VR program; 10 sessions No comparator (compared pre- post- treatment)</td>
<td>• There were improvements in Gross Motor abilities (P = 0.008), particularly with respect to standing (P = 0.007) and walking (P = 0.005), 6 minute walk test endurance improved (P = 0.002), as did autonomy in daily activities (P = 0.025). • Authors concluded that the 10 session GRAIL program was effective in improving walking ability in children with acquired brain injury</td>
</tr>
</tbody>
</table>

CP = cerebral palsy; NR = not reported; RCT = randomized controlled trial; PT = physiotherapy; SD = standard deviation; VR = virtual reality.
References Summarized

Health Technology Assessments

No literature identified.

Systematic Reviews and Meta-analyses


Randomized Controlled Trials


PubMed: PM26311943

Non-Randomized Studies

Comparative Studies

PubMed: PM27883988

Non-Comparative Studies

PubMed: PM28116417
Appendix — Further Information

Previous CADTH Reports


Randomized Controlled Trials

Study Protocol


Non-Randomized Studies - Pilot and Feasibility Studies


Review Articles
