Virtual Reality for Stroke Rehabilitation

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Virtual reality and interactive video gaming have emerged as new treatment approaches in stroke rehabilitation. These approaches may be advantageous because they provide the opportunity to practice activities that are not or cannot be practiced within the clinical environment. Furthermore, virtual reality programs are often designed to be more interesting and enjoyable than traditional therapy tasks, thereby encouraging higher numbers of repetitions. The use of specialized virtual reality programs designed for rehabilitation is not yet commonplace in clinical settings. However, gaming consoles are ubiquitous.

The primary objective of this review was to evaluate the effects of virtual reality and interactive video gaming compared with an alternative intervention or no intervention on upper limb, lower limb, and global motor function after stroke. Secondary outcomes included activity limitation and adverse events. We also explored feasibility of the approach by examining recruitment rates.

Search Strategy
We searched the Cochrane Stroke Trials Register (March 2010), the Cochrane Central Register of Controlled Trials (The Cochrane Library 2010, Issue 1), MEDLINE (1950 to March 2010), EMBASE (1980 to March 2010), and 7 additional databases. We also searched trial registries, conference proceedings, reference lists, and contacted key researchers in the area and virtual reality equipment manufacturers.

Selection Criteria
We included randomized and quasirandomized controlled trials comparing virtual reality with an alternative intervention or no intervention in people diagnosed with stroke. Virtual reality was defined as “an advanced form of human-computer interface that allows the user to ‘interact’ with and become ‘immersed’ in a computer-generated environment in a naturalistic fashion.”

Main Results
We included 19 trials that involved 565 participants. The sample sizes of the included studies were relatively small (range, 10–83) and interventions and outcome measures varied, limiting our ability to compare studies. Two studies used commercially available gaming consoles with the remaining studies using programs designed for rehabilitation. The most common intervention approach was upper limb training (used in 8 studies) in contrast to lower limb and gait training (3 studies), global motor function (3 studies), activity retraining (4 studies), and visual–perceptual retraining (1 study).

Results from 7 studies with 205 participants showed a statistically significant effect on arm function (standardized mean difference, 0.53; 95% CI, 0.25–0.81; Figure). We pooled 3 studies assessing the effect on gait speed and were unable to find a statistically significant effect. There were an insufficient number of comparable studies to assess the effect on global motor function. The effect on our secondary outcome of activity limitation showed statistically significant results based on 3 studies with 101 participants (standardized mean difference, 0.81; 95% CI, 0.39–1.22).

Few adverse events were reported. However, relatively low recruitment rates were evident (an average of only 34% of participants screened were recruited). In summary, we found limited evidence that the use of virtual reality and interactive video gaming may be beneficial in improving arm function and activities of daily living function when compared with the same dose of conventional therapy. There was insufficient evidence to reach conclusions about the effect on gait speed.

Implications for Practice
Virtual reality appears to be a promising intervention with reasonable effect sizes. However, at present, studies are too few and too small to draw conclusions. The lack of adverse events reported (such as motion sickness, headache, or nausea) suggests that this approach to therapy is relatively safe, although this may vary depending on the characteristics of the person, the virtual reality hardware and software, and the task.

Implications for Research
More randomized controlled trials are required. Furthermore, research is required to determine which types of virtual
Virtual reality programs are most effective, which type of patient is most likely to benefit, at what point in their rehabilitation it should be used, and how acceptable the approach may be to stroke survivors.

This review is published as a Cochrane Review in the Cochrane Database of Systematic Reviews. Cochrane Reviews are regularly updated as new evidence emerges and in response to comments and criticisms, and the Cochrane Database of Systematic Reviews should be consulted for the most recent version of the Review. The full article should be cited as: Laver KE, George S, Thomas S, Deutsch JE, Crotty M. Virtual reality for stroke rehabilitation. Cochrane Database Syst Rev. 2011;9:CD008349. (http://dx.doi.org/10.1002/14651858.CD008349.pub2).

**Sources of Funding**

K.L. is supported by an Australian Postgraduate Award Scholarship.

**Disclosures**

J.E.D. conducts research on virtual reality for stroke rehabilitation. This research is funded by various sources and presented at scientific and professional meetings. She is co-owner of a company that develops virtual reality for rehabilitation.

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**Figure.** Meta-analysis for the primary outcome, arm function. The figure shows a moderate significant overall treatment effect using a fixed-effect model.

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Virtual reality Mean</th>
<th>SD</th>
<th>Total</th>
<th>Comparison intervention Mean</th>
<th>SD</th>
<th>Total</th>
<th>Weight IV, Fixed, 95% CI</th>
<th>Std. Mean Difference IV, Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crosbie 2008</td>
<td>52.8</td>
<td>6.9</td>
<td>9</td>
<td>50.2</td>
<td>18.9</td>
<td>9</td>
<td>0.17 [-0.75, 1.10]</td>
<td></td>
</tr>
<tr>
<td>Housman 2009</td>
<td>24.9</td>
<td>7.4</td>
<td>14</td>
<td>19.6</td>
<td>6.7</td>
<td>14</td>
<td>0.73 [-0.04, 1.50]</td>
<td></td>
</tr>
<tr>
<td>Piron 2007</td>
<td>51.4</td>
<td>9.8</td>
<td>25</td>
<td>45.4</td>
<td>9.3</td>
<td>13</td>
<td>0.61 [-0.08, 1.30]</td>
<td></td>
</tr>
<tr>
<td>Piron 2009</td>
<td>53.6</td>
<td>7.7</td>
<td>18</td>
<td>49.5</td>
<td>4.8</td>
<td>18</td>
<td>0.62 [-0.05, 1.30]</td>
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</tr>
<tr>
<td>Piron 2010 (1)</td>
<td>49.7</td>
<td>10.1</td>
<td>27</td>
<td>46.5</td>
<td>9.7</td>
<td>20</td>
<td>0.32 [-0.27, 0.90]</td>
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</tr>
<tr>
<td>Saposnik 2010</td>
<td>-19.8</td>
<td>3.4</td>
<td>9</td>
<td>-27.4</td>
<td>8.7</td>
<td>7</td>
<td>1.15 [0.06, 2.24]</td>
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</tr>
<tr>
<td>Sucar 2009</td>
<td>30</td>
<td>12.4</td>
<td>11</td>
<td>26.36</td>
<td>2.33</td>
<td>11</td>
<td>0.39 [-0.45, 1.24]</td>
<td></td>
</tr>
</tbody>
</table>

Total (95% CI) 113 100.0% 0.53 [0.25, 0.81]

Heterogeneity: Chi² = 2.81, df = 6 (P = 0.83); I² = 0%

Test for overall effect: Z = 3.66 (P = 0.0003)

(1) Note that 3 people withdrew from control group therefore analysis done based on actual number contributing to outcome data
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*Stroke*. 2012;43:e20-e21; originally published online December 15, 2011;
doi: 10.1161/STROKEAHA.111.642439

*Stroke* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/43/2/e20

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