Effects of robot-assisted therapy on upper limb recovery after stroke: a systematic review

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CRD summary
This review concluded that robot-assisted therapy had the potential to improve proximal arm function following stroke. The authors' conclusions should be treated with caution in view of the uncertain clinical and statistical significance of the results and the small sizes of the included trials.

Authors' objectives
To assess the effects of robot-assisted therapy on motor and functional recovery of the arm following a stroke.

Searching
MEDLINE, CINAHL, EMBASE, the Cochrane Controlled Trials Register, DARE, SciSearch, DocOnline and PEDro were searched up to October 2006. Search terms were reported. Reference lists of relevant reviews were also searched. Only articles written in English, German or Dutch were included.

Study selection
Randomised controlled trials (RCTs) that evaluated the effect of robot-assisted therapy on motor and/or functional recovery of a paretic (partially paralysed) arm in patients diagnosed with stroke (cerebral vascular accident) were eligible for the review. Studies that compared two different types of robot-assisted therapy were excluded. Included studies evaluated five different devices compared with robot exposure or conventional therapy. Intervention time ranged from four to 12 weeks and therapy started from one week to more than six months after the stroke. Most studies used the Fugl-Meyer tool to assess motor recovery and the Functional Independence Measure to assess function (activities of daily living).

One reviewer selected articles for possible inclusion based on title and abstract. The authors did not state how many reviewers performed the final selection of studies for the review.

Assessment of study quality
Validity was assessed by two independent reviewers using the PEDro scale; disagreements were referred to a third reviewer. Studies scoring 4 or more out of a possible 10 were classified as high quality.

Data extraction
For continuous outcomes, the effect size (Hedge's g) was derived by calculating the difference between the means of the experimental and control groups divided by the average population standard deviation, or estimated from t values. Study authors were contacted for data if necessary. The authors stated neither how the data were extracted for the review nor how many reviewers performed the data extraction.

Methods of synthesis
Effect sizes were weighted by study sample size and pooled to produce a weighted summary effect size (SES; weighted mean difference) and associated 95% confidence interval. Statistical heterogeneity was assessed using the Q-statistic. A random-effects model was used if heterogeneity was significant. Effect sizes <0.2 were classified as small, between 0.2 and 0.5 as medium and >0.5 as large.

Results of the review
Nine RCTs (n = 218) were included. Quality scores ranged from 4 to 8 out of 10. Robot-assisted therapy was not significantly superior to control for motor recovery (SES 0.65, 95% CI: -0.02, 1.33) or functional recovery (SES 0.13, 95% CI: -0.23, 0.5); statistical heterogeneity was significant for motor recovery. The mean daily intervention time was longer for robotic therapy compared with control groups. A sensitivity analysis for motor recovery omitting one study that used bilateral distal arm training resulted in a statistically significant moderate effect size favouring robotic therapy (SES 0.36, 95% CI: 0.05, 0.65) without significant heterogeneity.
Authors' conclusions
Robot-assisted therapy has the potential to elicit improvements in proximal upper limb function following stroke.

CRD commentary
The inclusion criteria for the review were clear. The authors searched a range of relevant sources. Some language restrictions were imposed and unpublished studies were not sought, so the review could have been at risk of publication or language bias. Validity was assessed using a standard scale. Details of included studies were presented in tables. Methods to minimise reviewer errors or bias were reported for validity assessment, but not for study selection or data extraction, which made it difficult to assess this aspect of the review.

Studies were pooled by meta-analysis; significant heterogeneity for motor recovery was accounted for by a sensitivity analysis. The mean daily duration of robot-assisted therapy was longer than that of control interventions and this may have influenced the results. In view of the uncertain clinical and statistical significance of the results and the small sizes of the included trials, the authors' conclusions should be treated with caution. Their suggestions for further research seemed appropriate.

One of the authors holds patents and equity in a company that manufactures robotic technology.

Implications of the review for practice and research
Practice: the authors did not state any implications for practice.

Research: the authors stated that future research should distinguish between upper- and lower-arm training and should use kinematic analysis to differentiate between recovery based on neural repair and recovery based on compensation strategies. They also stated that there is a need to investigate the cost-effectiveness of robot-assisted therapy.

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This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract
contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.