Cochrane Corner

Electromechanical and Robot-Assisted Arm Training After Stroke
Updated Review

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Background and Purpose—More than two thirds of all patients after stroke have difficulties with reduced arm function. Electromechanical and robot-assisted arm training devices are used in rehabilitation and might help to improve arm function after stroke. Our systematic review examined the effectiveness of electromechanical and robot-assisted arm training for improving generic activities of daily living, arm function, and arm muscle strength in patients after stroke and also assessed the acceptability and safety of the therapy.

Methods—We searched the Cochrane Stroke Group’s Trials Register (last searched July 2011), the Cochrane Central Register of Controlled Trials (CENTRAL; The Cochrane Library 2011, Issue 7), MEDLINE (1950 to July 2011), EMBASE (1980 to July 2011), CINAHL (1982 to July 2011), AMED (1985 to July 2011), SPORTDiscus (1949 to July 2011), PEDro (searched August 2011), COMpendex (1972 to July 2011), and INSPEC (1969 to July 2011). We also hand-searched relevant conference proceedings, searched trials and research registers, checked reference lists, and contacted trialists, experts, and researchers in our field as well as manufacturers of commercial devices. Two review authors independently selected trials for inclusion, assessed trial quality, and extracted the data. The primary outcome was activities of daily living; secondary outcomes were impairments such as motor function and motor strength. To minimize bias we included only randomized controlled trials comparing electromechanical and robot-assisted arm training for recovery of arm function with other rehabilitation interventions or no treatment.

Results—We included 19 trials (involving 666 participants) in this review. Electromechanical and robot-assisted arm training did improve activities of daily living (standardized mean difference, 0.43, 95% CI, 0.11–0.75; P=0.009; I²=67%; Figure) as well as arm function (standardized mean difference, 0.45; 95% CI, 0.20–0.69; P=0.0004; I²=45%), but arm muscle strength did not improve (standardized mean difference, 0.48, 95% CI, −0.06 to 1.03; P=0.08; I²=79%). Electromechanical and robot-assisted arm training did not increase the risk of patients to dropout (risk difference, 0.00; 95% CI, −0.04 to 0.04; P=0.82; I²=0.00%), and adverse events were rare.

Conclusions—Patients who receive electromechanical and robot-assisted arm training after stroke are more likely to improve their generic activities of daily living. Paretic arm function may also improve, but not arm muscle strength. However, the results must be interpreted with caution because there were variations between the trials in the duration and amount of training, type of treatment, and in the patient characteristics.

Key Words: arm function ■ rehabilitation ■ robots ■ stroke

Our results were not conclusive. We found that patients who receive electromechanical-assisted arm training after stroke are more likely to improve their generic activities of daily living and may improve arm function. The findings indicate, however, that motor strength of the paretic arm is not more likely to improve when patients after stroke train with electromechanical devices or robots. Because adverse events were rare, based on the data of 19 trials, these devices could be applied as a rehabilitation tool, but we still do not know when and how often they should be used.

There is still a need for well-designed large-scale multicenter studies to evaluate benefits and harms of electromechanical-assisted arm training after stroke. Further research should address specific questions about the optimal type, timing, frequency, and duration of electromechanical and robot-assisted arm training.

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### Disclosures

None.

### Reference

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SUPPLEMENTAL MATERIAL

METHODS

Data Collection.

A trained abstractor collected data from the EMR using standard Centers for Disease Control and Prevention data definitions and entered the data into the MSR web-based data collection tool.¹

Outcomes.

Screening time and results had to be documented in the medical record by a healthcare professional. Results were coded as not done if there was no documentation of a swallow screen being done, and were coded as missing if the results of the screen were not documented. Contraindications to the swallow screen must be documented in the EMR to be abstracted.

Intervention.

An EMR based CDS embedded in the stroke admission order set with the following 4 key components:

1. **Dysphagia evaluation protocol (Figure 1):** A flow chart accessible through a hyperlink in the order set providing guidance on screening for dysphagia. The flow chart was created by speech and language pathologists at the study hospital based on the practice followed by them to screen stroke patients for dysphagia. Currently, there is no optimal bedside swallow screen recommended by the guidelines. However, a recent review identified valid elements for screening for dysphagia risk and also identified a
The water swallow test is an important part of the screen. The protocol as shown in the CDS flow chart includes a water swallow test and also many non-swallow elements (e.g. dysarthria) identified in the review as valid screening items.

2. **Pre-checked hard stop Dysphagia Screening order**: To be completed before the admission order set could be signed and released. Completion entailed a mandatory selection of 1 of the following 4 options: i) Failed screening; Strict NPO pending SLP (speech language pathology) evaluation; ii) Passed screening; No dysarthria; Regular diet with thin liquids; iii) Passed screening; Dysarthria present; Dysphagia 2 diet with thin liquids; Refer to SLP; iv) Refer to SLP.

3. **Default NPO diet**: There were 3 diet options and the NPO diet was the default. A different diet could be selected after unselecting the NPO diet and allowed combinations of diet consistencies (e.g. dysphagia Level 2, thick liquids).

4. **Prompt for documentation of dysphagia screening time and results of screening in the stroke history and physical EMR template**: To be completed before the admission note could be signed.

**Design of the dysphagia screening protocol.** The dysphagia screening protocol was put together by institutional Speech and Language Pathology (SLP) therapists in order to facilitate dysphagia screening by trainee resident physicians in the emergency department (ED). After much deliberation, a decision was made to use material (water) which was readily available in the ED. The protocol was only intended to be the preliminary screen; a more definitive evaluation involving material of multiple
consistencies was to be done by the SLP therapists. The rationale for using water in the protocol is described below.

Most dysphagia screens start with liquids and studies of dysphagic patients with fluoroscopy has found that laryngeal penetration was more likely with liquids rather than semisolid textures.³ This is true on clinical observation as well.⁴ One screen⁴ that starts with semisolids rather than liquids does so in order to minimize patients placed NPO (nothing by mouth). Our motivation was different: we wanted to minimize patients ordered oral intake incorrectly by resident physicians before the SLP therapists could perform a more comprehensive assessment. Hence, our goal with the screen was to achieve a high sensitivity in terms of identifying those at risk for aspiration. Currently, there is no single tool that has been designated as a standard screen by consensus.² Furthermore, while most stroke patients do worse with liquids than with semi-solid food, there are occasional brainstem strokes where the patient may do better with water rather than semi-solids. Our SLP therapists were aware of this and took this into account by screening for brainstem signs prior to swallow evaluation and making them NPO until further detailed evaluation. (Figure 1 exclusion criteria). Our SLP therapists then use more advanced food consistencies as needed.

We wish to point out however that the flowchart algorithm is specific to our institution and has not been proven to be the optimal way to triage patients.

RESULTS.

Online table compares baseline characteristics of patients before and after the intervention. While the proportion of patients presenting with aphasia and altered
consciousness was similar, the proportion of patients with weakness or paresis was lower post-intervention.

Additional References


8. Wolfe CD, Redfern J, Rudd AG, Grieve AP, Heuschmann PU, McKeveitt C.
Cluster randomized controlled trial of a patient and general practitioner
intervention to improve the management of multiple risk factors after stroke: stop
Online Table. Patient demographics and clinical features pre and post implementation of the EMR-based dysphagia screening Clinical Decision Support (CDS) tool.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pre-CDS (N=369)</th>
<th>Post-CDS (N=583)</th>
<th>P-value</th>
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<tbody>
<tr>
<td>Mean age ± standard deviation, years</td>
<td>64±16</td>
<td>64±16</td>
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<tr>
<td>Male, N (%)</td>
<td>203 (55)</td>
<td>309 (53)</td>
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<tr>
<td>Race</td>
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<td>White</td>
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<td>African American</td>
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<tr>
<td>Other</td>
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<td>78 (13)</td>
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**Stroke subtype & severity**

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<tr>
<td>Ischemic</td>
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<tr>
<td>Hemorrhagic</td>
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<td>Admission NIHSS</td>
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<td>NIHSS&lt;10</td>
<td>299 (81)</td>
<td>307 (53)</td>
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</tr>
<tr>
<td>NIHSS ≥10</td>
<td>68 (18.5)</td>
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<td>2 (0.5)</td>
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</table>

**GCS (Hemorrhagic strokes only)**

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<td>GCS ≥13</td>
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**Clinical Features**

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<tr>
<td>Aphasia</td>
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<td>------------------------</td>
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<tr>
<td>Altered level of consciousness</td>
<td>72 (20)</td>
<td>155 (27)</td>
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<td>Weakness</td>
<td>263 (71)</td>
<td>352 (60)</td>
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