Evidence-based arm rehabilitation after stroke - an overview

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For patients with arm paresis following a stroke, does rehabilition therapy in different “doses” or with different content lead to a reduction in the paresis, an improvement in active mobility and strength and in arm activity? This issue is addressed in the following article.

Task-specific training for the arm is based on a task relevant to everyday life. (Source: Thieme Group; icon)

There are a variety of treatment options that can be used in the case of arm paresis after a stroke [1, 4]. In addition to the therapy content, other aspects such as organisation and ‘dosage’ also play an important role in the clinical decision [3].

This article provides an overview of the conclusions for clinical practice that can be drawn from current knowledge of their clinical efficacy. The article is based on evidence from the S3 Guideline “Rehabilitative Therapy for Arm Paresis following a Stroke” which

was developed by several expert associations under the leadership of the German Society of Neurorehabilitation (DGNR) and which addresses the following issue: In the case of patients who have suffered a stroke and arm paresis, does rehabilitative therapy (e.g. physiotherapy, ergotherapy, acupuncture, electrostimulation, robot-assisted therapy, biofeedback therapy, medication) delivered in different "doses" (e.g. different therapy durations) or different content lead to a (different) reduction in the paresis, an improvement in active ability to move and strength, as well as in arm activity?

Studies The evidence from randomised controlled studies (RCS) is the clinical scientific information that is most likely to enable valid evaluations. Systematic reviews (SR) summarise the data from the current available RCS and, through meta-analyses, which analyse the efficacy across studies from a statistical perspective, they can determine the current state of the science regarding the therapy effects and their strengths.

Guidelines Accordingly, the guidelines (GL) systematically searched for RCS and SR, critically assessed them and derived recommendations for clinical practice from the evidence [2]. The GL is near completion; publication by the Association of the Scientific Medical Societies in Germany, (AWMF) is expected soon (www.awmf.org/leitlinien/detail/ll/080-001.html). The guideline spans more than 270 pages. Thus reproduction of the content is not possible. There should be an attempt to summarise the key aspects for clinical practice that can be derived from the evidence. The conclusions for practice shown here, however, do not represent the formally agreed recommendations from the guideline. Readers are advised to acquaint themselves with the original text of the guideline in more detail and to identify the specific recommendations from the guideline themselves.

Methodology

Initially, and repeatedly over past years, there has been a systematic search for randomised controlled studies and systematic reviews including randomised controlled studies if they contribute to the issue addressed by the guideline. The last systematic search was dated July 2017.

After selecting the references using inclusion and exclusion criteria, an assessment of the validity of the individual references was carried out first using a standardised checklist. The most important data relevant to the issue addressed in the guideline was then extracted from the individual publications and, for each individual reference, an assessment was made as to the consequences for practice resulting from this data. For the different references, a synopsis was then created showing all randomised controlled studies and systematic reviews included for the individual interventions together with their results, on the one side in evidence tables and, on the other side, as a text summary.

Recommendations were then derived in the guideline based on this summary, the overview of the results for a form of intervention or a particular issue within arm rehabilitation. When deriving the recommendation, it was important to take into account the subgroup of stroke patients with arm paralysis - in other words, minor, medium, seriously affected patients or and the time period of the treatment after the stroke (soon or later) - for which treatment of whichever type achieves which effect and which target figure. In doing so, the quality of the evidence was assessed according to GRADE, then a recommendation and its recommendation grade were documented with an overview of the effects on one side and the quality of the evidence on the other. In the full text version of the guideline, this is initially provided in a long text; at the end of this text there is an overview of the recommendations spanning approximately 20 pages.

As mentioned above, it is not even possible to reproduce the recommendations here 1:1, however an overview of important conclusions from the evidence for clinical practice should be provided.

Results

Study situation and study quality

Following a systematic literature search on PubMed and in the Cochrane Library, a total of 411 randomised controlled studies could be used for the evidence-based process, together with 114 systematic reviews. The methodological quality of the included studies was mainly good, whereby a not insignificant share of the publications were also assessed as having insufficient internal validity. However, even in the randomised controlled studies for which the methodology was adequate, there were more frequently weaknesses in the detail which affected the interpretation. This sometimes related to the comparability of intervention and control group at the start of the study, and also to the fact that often not all subjects in the study group were evaluated as they were originally assigned (no "intention to treat" analysis). Often effects were only assessed at the end of an intervention, but the persistent effects of the treatment were not documented after a period without therapy. Side-effects were also frequently not documented.

Nonetheless, it is striking that, with regards to the issue of arm rehabilitation after a stroke, there are even as many randomised controlled studies as well

as many systematic reviews and meta-analyses. Even if the evidence highlights weaknesses, there is still a very extensive data basis with primary (sufficient) high-quality studies (randomised controlled study) and thus there is definitely the opportunity for an extensive evidence-based derivation of recommendations.

Intensity and organisation forms

If an acceleration in recovery of arm activities is desired in the case of sub-acute stroke patients, 30 minutes of specific therapy per day is advisable. Specific arm training of two to three hours per day can generate increased effectiveness in movement selectivity and arm activity. In later phases after a stroke, depending on the individual treatment goals, structured repetitive training of 90-270 minutes per week may be advisable to achieve functional improvements.

Therapy need not necessarily be as a single treatment. Circuit training in small groups is also an option as is individual training, including at home, if this is well structured and subject to regular therapeutic supervision. Telerehabilitation options can also be used. Furthermore, training with nursing staff or family members given therapeutic instruction can be a helpful additional offering.

Treatment without the use of a device

Arm rehabilitation treatment targeting an improvement in function and activity should include active training. This is possible with bilateral training, although the advantages thereof could not be shown. For mildly affected patients in the chronic stage, this tended to be inferior.

Damage-focussed training in the context of basic arm training should be included in the treatment offered to sub-acute patients with severe paralysis if the goal is to achieve an improvement in selective mobility. For patients with mild arm paresis, arm ability training should be included in the sub-acute stage to increase the performance of the sensory motor system if this is a focus of the treatment.

Task-specific training, in which exercises are always carried out in the context of an everyday task, shows a statistically stable effect on the arm and hand function, although this varies across studies and cannot always be represented as safe. It thus represents a therapy option if an improvement in the arm activity is the therapeutic goal.

Cognitive Sensory Motor Training as per Perfetti can also be performed with acute stroke patients with severe arm paresis in order to improve arm activity.

A further option is functional strength training that relates to a task and targeted strength development.

With mirror therapy, the affected patient performs movements with his less affected hand and observes these in a mirror with the impression that the paralysed hand is moving normally. Mirror therapy is recommended for sub-acute and chronic stroke patients with moderate arm paresis, if applicable, as supervised self-training, if an improvement in motor functions is desired.

Similarly, mental self-training can also be offered whereby the patient mentally repeats exercises performed with the affected arm afterwards.

For patients who could use their arm in a functional way, but do not do this spontaneously, in other words, they demonstrate “learned non-use”, movement induction therapy or Constraint-Induced Movement Therapy (CIMT) can be useful to achieve greater use of the affected arm in everyday activities, if the therapy can be implemented from an organisational perspective.

Non-motorised, mechanical therapy devices

There is a whole range of devices that can be used in arm rehabilitation. They support the patient in practising repetitive arm movements without these devices being motorised. These include “BATRAC: bilateral arm training with rhythmic auditory cueing" or the “Reha-Slide", also known as the “Nudelholz” (rolling pin), arm ergometer or other devices. These can be offered to patients, particularly those with serious arm paralysis in the sub-acute stage, in order to support the active hand and arm function.

Also devices that use a virtual reality application can be used in an institute or for self-training at home to improve the selective mobility or active movement measurements.

Robotic arm therapy

In the case of severe paralysis, particularly in the sub-acute stage, robotic arm therapy is a useful therapeutic addition, if it is possible from an organisational perspective. The robotic arm therapy can provide technical support to the patients under supervision and they can practice specific movements with high repetition rates which they would otherwise not be able to perform themselves. Depending on the device,

it is possible to train the shoulder and elbow, lower arm and wrist movements or finger movements. In the chronic stage too, robotic arm therapy can be offered for these indications.

Electrostimulation

Neuromuscular electrostimulation, whereby peripheral nerves and muscles are stimulated directly, and is if applicable, linked to a volitional activity via a electromyographic trigger, represents a further technical possibility to treat even severely paretic arm muscle groups. Overall, the evidence is extensive, yet still weak, which is why treatment with electrostimulation is judged to be an option.

Neuromuscular electrostimulation of the shoulder muscles in the sub-acute stage is given particular consideration for the treatment or prevention of a subluxation, or for treatment of the wrist and finger extensors in the case of severe incomplete hand and finger paresis, if possible, EMG-triggered. For patients with severe incomplete hand paralysis, but with at least partially retained proximal motor skills with movement and holding function, functional multi-channel electrostimulation (FES), which enables grip and release through electrostimulation, can be offered in order to practice everyday activities with the therapy goal of improving distal selective mobility (hand and fingers).

With electrostimulation as a whole the device-specific contraindications must be taken into account.

Non-invasive brain stimulation

Repetitive transcranial magnet stimulation (rTMS) In clinical studies, both the inhibitory low frequency rTMS (“low frequency, LF”) of the unaffected hemisphere as well as the excitatorily rTMS (“high frequency, HF”) for the affected hemisphere showed sustained positive therapeutic effects of moderate clinical-relevant strength. The result was best soon after the stroke and strongest in studies with five therapy sessions. These results are applicable for patients with mild to moderate arm paresis. Based on this evidence, a recommendation for clinical use in the sub-acute stage is justified, in the chronic stage it is an option. Both the safety standards, the contraindications and the medical product legislation aspects must also be taken into account.

Transcranial direct current therapy (rDCS) With sub-acute and chronic stroke patients with moderately severe to severe arm paresis, in the case of generally unstable verifiable positive therapy aspects neither an anodal (excitatorily) stimulation (atDCS) of the ipsilesional motor cortex nor a cathodal stimulation of the contralesional (ktDCS) context or a combined bihemisphere stimulation are recommended outside of study protocols.

Medication

With Botulinum toxin A in particular, there is a clear indication for Botulinum toxin-A in the case of severe paresis, which, due to the spasticity, affects how well the paralysed arm can be integrated in everyday activities, in other words, the passive functions. In these cases, treatment with Botulinum toxin-A should be considered. This could also have a positive effect on pain around the spastic paresis.

However, in the case of patients with spasticity, to encourage active arm motor skills, or rather the arm function, Botulinum toxin-A is not generally recommended, either soon after or later following the stroke. In individual cases, however, treatment of spasticity with Botulinumtoxin A can help to support the active function and, in this context, can then also be used.

Stimulation of motor recovery There are several medications for which there is given evidence that their use could improve functional recovery - particularly in the case of severe arm paresis. These include L-Dopa, Fluoxetin and Cerebrolysin. Specifically, these medications can support the recovery function soon after the stroke and, based on the evidence, could be used in this context. However, it must be noted that their use represents an OFF label prescription (L-Dopa, Fluoxetin) and Cerebrolysin is not approved and available everywhere (e.g. in Austria)

For other medications, such as Donepezil or D-Amphetamin, the data available does not justify use in arm rehabilitation after a stroke.

Taping and ortheses

Wearing wrist support splints and glehonumeral shoulder taping for several hours can have a positive, even propylactic effect on pain in the treated joints in the case of severe arm paralysis and can be used if this is the treatment goal. This also applies to other supports that prevent a severely paralysed arm from hanging down, such as the use of a positioning pillow or a wheelchair table. These should generally be given consideration (expert opinion).

Support ortheses and taping of joints of the severely affected, centrally paretic arm do not stimulate active function recovery. They should not be used for this treatment goal.

As the evidence from the Arm Rehab Guideline shows, there is a broad range of knowledge from clinical studies and systematic reviews with metaanalyses to show that and how rehabilitative treatment can stimulate the recovery of the arm function, both at the damage level and at the activity level and, with reference to the subjective assessment, the usefulness of the arm for everyday tasks.

Efficacy was always proven if arm rehabilitation was specifically focussed on the problems of the central paralysed arm. In the case of severely paralysed arms, this specifically related to the restoration of selective movement; with mildly affected persons, it was the improvement in sensory motor functions with precision, fine and targeted motor functions.

Special attention must be given to the fact that, for the many different, including alternative, forms of treatment that are available, treatment takes place at the limit of performance, in other words the patient should neither be under or overextended with regard to his motor skills performance. It is important that he concentrates on the specific aspects of the motor control to be improved and that he performs this training in high doses, in other words, with high repetition rates. This is because a high repetition rate with specific content is required when learning motor skills.

In the case of severe paresis, devices are often useful which enable the initial movement. These may be passive or active devices. Alternatively, support provided by the therapist can also enable a movement which would not be possible alone.

In the case of mild paresis, it is important that the performance limit is supported in such a way that achievement orientation is actually possible.

With regard to the organisation, in principle, there are individual therapies available which can ensure a specific level of structure and support. In addition, group treatment or home training are also conceivable. However, in this case, for each patient it must be determined whether the therapy content and organisational and patient-specific prerequisites can be implemented in such a way that the above mentioned basic principles of motor function rehabilitation can be achieved with the arm treatment in a group or at home. Unfortunately this is often not the case - then even treatment forms that are organisationally more suitable will not result in therapy success and thus are neither clinically beneficial nor cost effective.

The option to support the training with other forms of treatment that can stimulate the functional reorganisation of the brain is certainly of interest. These include repetitive transcranial magnetic stimulation and medications that act on the central nervous system to modulate the cerebral networks and transmitter systems which are important for learning motor skills and for the recovery of motor skills.

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DOI https://doi.org/1 0.J055/a-J 1 56-3752
neuroreha 2020; 12: 58—62

ISSN J 61 J-6496