Best Practice for Adults Post-CVA Occupational Therapy Intervention

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CLINICAL SCENARIO: Hilda is 56 year old female who experienced a middle cerebral artery stroke in the right side of her brain resulting in left sided hemiparesis. Her occupational therapist is focusing on her functional abilities, which entails teaching her compensatory strategies to overcome challenges rather than trying to improve the use of her left arm using remedial strategies. Hilda is not pleased with this direction, insisting that to return to her prior occupation as a secretary and to drive again, she must have use of her left arm. She and her son are challenging the OT to provide evidence to support her compensatory intervention strategy.

FOCUSED CLINICAL QUESTION: Do adults post-CVA achieve better occupational performance outcomes with a compensatory approach or a remedial approach?

SUMMARY of Search, 'Best' Evidence' appraised, and Key Findings:

- A systematic review was found comparing the evidence on repetitive task training post stroke.
- A systematic review was found comparing exercise therapy for arm function in patients post stroke.
- A meta-analysis was found comparing strength training on upper limb function post stroke.
- A systematic review was found comparing the outcomes of the Bobath concept on upper limb recovery following stroke.
- A randomized control trial was found comparing forced use therapy on upper limb function following stroke.
- A systematic review was found comparing the effectiveness of constraint induced movement therapy on upper limb function.
- A systematic review was found comparing the effectiveness of electromechanical and robot-assisted arm training for improving activities of daily living and arm function and motor strength of patients after stroke.
- A systematic review was found comparing the effectiveness of electrostimulation on improving functional motor ability and the ability to undertake activities of daily living.
- A systematic review was found comparing the effectiveness of virtual reality in stroke rehabilitation for upper limb motor recovery.
- A quasi-experimental design was found that examined outcomes of functional independence when occupational adaptation frame of reference is implemented.
- A pre-post test design was found that examined compensatory strategies for stroke patients.
- A randomized control trial was found comparing constraint induced movement intervention with traditional interventions.

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CLINICAL BOTTOM LINE:
Research is heavily weighted towards the remedial approach. The results of this research indicate that when this type of treatment is implemented as part of the therapy process, improvement is noted with movement and strength of the affected limb. However, the results do not translate to improved performance with ADLs. Due to time constraints of therapy and the difference between each individual's rehabilitation potential, there are situations when a compensatory approach may be necessary to accomplish the goal of participation in occupations.

Limitations of this CAT:

While there is an abundance of research on numerous remedial interventions for adults post stroke, there is very little research on compensatory strategies and interventions. Teaching compensatory strategies is a large part of the occupational therapy protocol for treating individuals following a stroke, but we were not able to locate any articles that specifically addressed the effectiveness of this type of intervention. In many research articles considering the effectiveness of various remedial interventions, there is a control group or alternative group that is defined as receiving compensatory therapy. There is also consistently a large variation between the duration, intensity, and type of intervention provided even when the intervention is intended to be the same.

SEARCH STRATEGY:

Terms used to guide Search Strategy:

- **P**atient/Client Group: Adults post-CVA
- **I**ntervention (or Assessment): Constraint Induced Movement Therapy; Neurodevelopment Treatment; Virtual Reality Treatment; Repetitive Task Training; Strength Training; Exercise Therapy; Robotic Therapy;
- **C**omparison: Compensatory intervention and remedial intervention
- **O**utcome(s): Occupational performance skills including but not limited to upper limb strength, upper limb function, upper limb function with ADLs, grip strength, pinch strength, hand function, and numerous standardized assessments

Databases and sites searched	Search Terms	Limits used
-Cochrane Library -American Journal of Occupational Therapy -OT Seeker -Google Scholar -CINAHL -PubMed -OT Search -EBSCO Host	-stroke -compensatory strategies -remedial strategies -dressing technique -CVA -ADLs -NDT -Robotics -Virtual reality -CIMT -Restorative Therapy -Post stroke occupational therapy -ADL Retraining -One handed Adaptations -Rehabilitative Therapy	-English only -Holmes level I-III -Human subjects only -Published from 1997-2010

INCLUSION and EXCLUSION CRITERIA

- Inclusion:
  - Published between 1997-2010
  - English only
  - Holmes level III and above
  - Peer reviewed journal
  - Diagnosis of CVA
  - At least some form of hemi-paresis of the upper extremity
- Exclusion:
  - We did not exclude any articles that met our inclusion criteria

RESULTS OF SEARCH

Table 1: Summary of Study Designs of Articles retrieved

Study Design/ Methodology of Articles Retrieved	Holm's Level	Number Located	Author (Year)
Systematic Reviews	Level I	7	• Van der Lee, Snels, Beckerman, & Lankhorst (2000) • French, Thomas, Leathley, Sutton, McAdam, Forster, Langhorne, Price, Walker & Watkins (2007)

			• Hakkennes, S. & Keating J. (2005) • Henderson, A., Korner-Bitensky, N., & Levin, M. (2007) • Luke, C., Dodd, K. J., & Brock, K. (2004) • Mehrholz, J., Platz, T., Kugler, J., & Pohl, M. (2009). • Pomeroy, V., King, L., Pollock, A., Baily-Hallam, A., & Langhorne, P. (2009).
Meta-analysis	Level I	1	• Harris, J. & Eng, J. (2009)
Randomized Control Trials (multi-site)	Level II	1	• Van der Lee, J. H., Wagennar R. C., Lankhorst, G. J., Vogelaar, T. W., Deville, W. L., & Boutler, L. M. (1999)
Randomized Control Trails (one site)	Level II	1	• Dromerick, A.W., Edwards, D.F., Hahn, M.
Quasi-experimental design	Level III	1	• Gibson, J.W., Schkade, J.K.
Pre-Post test design	Level III	1	• Heugten, C.M., Dekkeer, J., Deelman, B.G., Dijk, AJ. V., Stehman-Saris, J.C., Kinebanian, A.

BEST EVIDENCE

The following studies/papers were identified as the 'best' evidence and selected for appraisal. Reasons for selecting these studies are included for each article:

- Dromerick, A.W., Edwards, D.F., & Hahn, M. (2000). Does the application of constraint-induced movement therapy during acute rehabilitation reduce arm impairment after ischemic stroke? *Stroke*, *31,* 2984–2988.
- French, B., Thomas, L. H., Leathley, M. J., Sutton, C. J. McAdam, J., Forster, A., Langhorne, P., Price, C. I. M., Walker, A., & Watkins, C. L. (2007).

Repetitive task training for improving functional ability after stroke. *The Cochrane Database of Systematic Reviews, 4,* 1-74.
- Gibson, J. W., & Schkade, J. K. (1997). Occupational adaptation intervention with patients with cerebrovascular accident: A clinical study. *American Journal of Occupational Therapy, 51,* 523–529.
- Hakkennes, S., & Keating, J. (2005). Constraint induced movement therapy following stroke: A systematic review of randomized controlled trials. *Australian .Journal of Physiotherapy, 51,* 221-231.
- Harris, J. E., & Eng. J. J. (2010). Strength training improves upper-limb function in individuals with stroke: A meta-analysis. *Stroke, 41,* 136-140.
- Henderson, A., Korner-Bitensky, N., & Levin, M. (2007). Virtual reality in stroke rehabilitation: A systematic review of its effectiveness for upper limb motor recovery. *Topics in Stroke Rehabilitation, 14*(2), 52-61.
- Luke, C., Dodd, K. J., & Brock, K. (2004, May 30). Outcomes of the Bobath concept on upper limb recovery following stroke. *Clinical Rehabilitation, 18,* 888-898.
- Mehrholz, J., Platz, T., Kugler, J., & Pohl, M. (2009). Electromechanical and robot-assisted arm training for improving arm function and activities of daily living after stroke. *Cochrane Database of Systematic Reviews*, *4,* 1-43.
- Pomeroy, V., King, L., Pollock, A., Baily-Hallam, A., & Langhorne, P. (2009). Electrostimulation for promoting recovery of movement *or functional ability after stroke. Cochrane Database of Systematic Reviews, 2,* 1-68.
- Van der Lee, J. H., Snels, I. A. K., Beckerman, H., Lankhorst, G. J., Wagenaar, R. C., & Bouter, L. M. (2001, September 30). Exercise therapy for arm function in stroke patients: A systematic review of randomized control trials. *Clinical Rehabilitation, 15,* 20-31.
- Van der Lee, J. H., Wagenaar, R. C., Lankhorst, G. J., Vogelaar, T. W., Deville, W. L., & Boutler, L. M. (1999). Forced use of the upper extremity in chronic stroke patients: Results from a single-blind randomized clinical trial. *Stroke, 30,* 2369-2375.
- Van Heughten, C.M., Dekker, J., Van Dijk, A., et al. (1998). Outcome of strategy training in stroke patients with apraxia: a phase II study. *Clinical Rehabilitation, 12,* 294-303.

Reasons for selecting these studies:
- Studies met inclusion criteria

SUMMARY OF BEST EVIDENCE

Table 2: Description and appraisal of the systematic review of Luke, C., Dodd, K. J., & Brock, K.

Objective of the Study: To evaluate the Bobath concept effectiveness at minimizing upper limb impairments, activity limitations, and restrictions on participation post stroke. **Study Design**: Systematic review **Search strategy**: The following databases were searched: CINAHL, MEDLINE, EMBASE, DARE, Cochrane Library, PEDro, PubMed, AMED, AMI, CSA Neurosciences, and Psych Info. Keywords: stroke, CVA, Cerebrovascular accident, Cerebrovascular disorder, Cerebral ischemia, Cerebral haemorrhage, Cerebral infarction, Brain injury, Hemiplegia*, Hemiparesis, Neuromuscular facilitation, Bobath,

NDT, Neurodevelopmental theory, Therapeutic facilitation, Proprioceptive facilitation, Arm, Hand, Upper limb, Upper extremity.
Selection Criteria: 1) a population of adults (18 years or older) diagnosed with a stroke 2) stated use of the Bobath concept or neurodevelopmental therapy in isolation 3) a control group for Bobath intervention in the form of either a group with no intervention, or a group with a comparison intervention, or a baseline phase 4) an outcome measure reflecting change in upper limb impairment, activity limitations, or participation restriction.
Methods: A total of 688 articles were compiled. Of the 688 found only eight met the inclusion criteria. The eight consisted of five randomized control trials, one single-group cross-over design, one B-C B-C single-case design, and one with a mixed single-case A-B design coupled with a randomized control trial (RCT) design. Two reviewers examined the methodological quality of the articles independently. In general, the methodological quality of the included studies was poor.
Outcome Measures
Outcomes of these were assessed using the following domains of the International Classification of Functioning and Disability (ICF): impairment, activity limitation, and participation. Effect sizes were calculated using a 95% confidence interval.
Main Findings:
Regarding the ICF health domain of impairment,:limited evidence supports the idea that the Bobath concept can reduce muscle tone; the Bobath concept was evidenced to improve shoulder pain better short term but not long term than cryotherapy; the Bobath concept was not found to be more effective than other interventions in improving muscular strength; and this intervention was found to be better than other approaches at improving motor control. The ICF domain of activity limitation review concluded that significant differences between individual effect sizes were not found between the results of the Bobath concept and other intervention approaches. The effects of the Bobath concept on the ICF domain of participation were contradictory.

Original Authors' Conclusions
The Bobath concept was not found to be more or less effective in treating patients post CVA than any other upper limb rehabilitation approaches. A limitation of this systematic review is that the included studies lack methodological rigor and utilized different outcome measures. Future research should include more specific inclusion criteria regarding the similarity of the subjects studied, similar outcomes measures, and therapists trained to implement the Bobath concept.

Critical Appraisal:
Validity: Holmes Level I, Systematic review-moderate strength
Importance of Results: This review was consistent with two previous reviews in concluding that the Bobath concept is overall no more effective than other post CVA interventions.
Implications for Practice: The Bobath concept should not be utilized as a means of best practice in treating post CVA.

Table 3: Description and appraisal of the meta-analysis of randomized controlled trails by Hakkennes, S., & Keating, J.L.
Objective of the Study: The purpose of this review was to evaluate the effectiveness of Constraint-induced movement therapy in increasing upper extremity function post CVA.
Study Design: Meta-analysis

Search Strategy: The following online databases were searched: Medline, CINAHL, EMBASE, The Cochrane Library, PEDro, and OT Seeker. Keywords: Another article was referenced in order to find the keywords used to obtain the articles included in this systematic review. The authors referred readers to another reference to obtain key search terms.
Selection Criteria: 1) Some form of CIMT was compared with no intervention or with alternative treatment. Papers reporting CIMT provided in concert with other interventions were eligible for inclusion provided these other interventions were applied equally to comparison group(s) 2) Trial participants were over 18 years ad exhibited reduced functional use of an upper extremity as a result of a stroke 3) The study design was either a randomized or quasi-randomised controlled trail including cross-over design or a systematic review of the randomized controlled trials 4) The trial reported scores for at least one measure of upper limb function 5) Trials were reported in English. 6) Results were reported in journal publications.
Methods: The search results found a total of 1339 articles. 18 articles met inclusion criteria. Four articles were systematic reviews and 14 were RCTs. The methodological rigor of the included articles was evaluated using the PEDro scale. The inclusion criteria for participants varied significantly. The intervention approaches of these studies also varied in duration, setting, type of restraint, and intensity. Randomized procedures were adequate.
Outcome Measures: The outcomes were evaluated using scales that took into account continuity, the number in the sample, pre- and post- test intervention means, and standard deviations. If possible, effect sizes were reported. Outcome measures varied in each trial. Of the 14 included trials, one of the five outcome measure were found to be statistically significant, The Motor Activity Log which was used in eleven of the fourteen trials.
Main Findings: The study concluded that assessed six CIMT studies in physical therapy found that one of the two outcomes measures had significant results. There was no consistent outcome measure reported across all trials. In the future it is important to compare the amounts of time the unaffected arm is constrained.
Conclusions: This systematic review found it was hard to come to make a conclusion on the effects of CIMT due to the limited amount of evidence and the lack of assessment validity. For further research it is recommended that specific standardized outcome measures be utilized. Future research studies should also investigate the best time post CVA to begin CIMT. The study officially concluded that CIMT may improve upper limb function post CVA when compared to other treatments or no treatment at all. Evidence did not support that CIMT effected patient's quality of life or independence in ADLs. One specific protocol of CIMT versus another was not shown to be more effective. All in all, higher quality larger sample size research studies need to be conducted in order to support the use of CIMT for patients post CVA.

Critical Appraisal:
Validity*:* Holm's Level I, Moderate Strength Meta-analysis
Importance of Results: These results concluded that more research needs to be done.
Implications for Practice: To date, sufficient evidence does not exist to support the use of CIMT in improving independence of post CVA patients in ADLs.

Table 4: Description and appraisal of the single-blind randomized clinical trial by Van der Lee, J. H., Wagenaar, R. C., Lankhorst, G. J., Vogelaar, T. W., Deville, W.L., & Bouter, L. M..

Objective of the Study: This study aimed at evaluating the effectiveness of forced use therapy.
Study Design: This study was a single-blinded randomized clinical trial. The evaluator was blinded in this study. Participants were randomly assigned into two groups using a computer system. The treatment that each group received was chosen by one of the authors. One group received forced use therapy for two weeks and the other group received bimanual training based on NDT for two weeks. The time between treatment allocation and start of the intervention varied because both interventions could not be given simultaneously. Baseline measurements were taken at two weeks and three to five days pre-intervention. Four follow-up measurements were taken at three weeks, six weeks, six months, and one year post intervention.
Setting: An outpatient clinic at the Department of Rehabilitation Medicine of the University Hospital Vrije Universiteit in Amsterdam.
Participants: The study included 66 patients. The patients were recruited from the Department of Rehabilitation Medicine of the University Hospital Vrije Universiteit in Amsterdam and four other rehabilitation facilities in the area. Inclusion criteria were: 1) a history of a single stroke, at least one year before the start of the study, resulting in hemiparesis of the dominant limb 2) a minimum of 20 degrees of active wrist extension and 10 degrees of finger extension 3) Action Research Arm (ARA) test score <51 (maximum score of 57) 4) age 18 to 80 years 5) ability to walk indoors without a stick, indicating no major balance problems 6) no severe aphasia (score >P50 on the Stitching Afasie Nederland (SAN) 7) no severe cognitive impairments (Mini-Mental State Examination score $\geq$ 22. The median age was 61 and the median age since stroke was three years. Four patients dropped out of the study for various circumstances. All four follow up data points were obtained for 58 of the 62 patients.
Intervention Investigated: All patients received their allocated treatment six hours a day, five days a week for two consecutive weeks. Patients in the experimental group had their unaffected arm immobilized by a resting splint and closed arm sling. The control groups received NDT based interventions. This group completed all activities bimanually. Treatment was focused on housekeeping activities, handicrafts, and games. The activities were supervised by physical therapists or an occupational therapist.
Control: The group receiving a reference therapy of bimanual therapy based on neurodevelopmental theory.
Experimental: The group receiving forced use therapy.
Outcome Measures: Intake measurements: Two measurements were taken at the beginning of the study,sensory disorders and hemineglect. Sensory disorders were rated as positive using a dichotomous scale. Hemineglect was evaluated using a letter cancellation test. Primary Outcome Measures: The personal care and occupational domains of the Rehabilitation Activities Profile (RAP) was used. Dexterity was examined using the ARA. Secondary Outcome Measures: The upper limb portion of the Fugl-Meyer Assessment (FMA) was used to measure the ability of the subject to move the affect arm outside of synergetic patterns. The Motor Activity Log (MAL) was used to analyse the amount of use and quality of movement of the affected arm.
Main Findings: A significant main effect was found in the ARA. This difference in the two groups was still present up to the one year follow-up mark. Overall, the RAP showed no significant differences over time in either group. The FMA found that no treatment effect was present in either of the groups. A significant interaction effect between treatment and neglect on the MAL amount of use scores, with participants demonstrating neglect doing better than those without neglect.. In neither the short

nor long term were statistically significant differences found between the two groups on the MAL amount of use or quality of movement scale.
Original Authors' Conclusions: This study found a small yet lasting effect on intervention of forced use therapy versus NDT based interventions regarding the dexterity of the upper limb as evidenced by the ARA scores. The study found no significant effects of forced use therapy regarding ADL outcomes measures or impairment as evaluated by the FMA.

Critical Appraisal:
Validity*:* Holmes Level II; Strong AACPDM rating
Interpretation of Results: Forced therapy was found to have a measurable long term effect on dexterity of post CVA patients.
Conclusion: Occupational therapists should consider this a supported intervention in treating patients post CVA. Further research should be conducted in order to more strongly support the findings presented in this article.

Table 5: Description and appraisal of the meta-analysis by Harris, J. E., & Eng, J. J.
Objective of the study: To examine the evidence collected on the effectiveness of strength training of the paretic upper limb to improve strength, upper limb function, and performance of ADLs.
Study Design: Meta-analysis
Search strategy: The following electronic databases were searched from 1950 to April 2009: Cochrane Database of Systematic Reviews; MEDLINE; Cumulated Index to Nursing and Allied Health Literature; EMBASE; and Physical Therapy Evidence Database. The key search words included: "cerebrovascular accident"; "stroke"; and "hemiparesis" paired with "rehabilitation", "exercise", "strength", "activities of daily living", or "upper limb". Hand searches of relevant journals and reference lists from systematic reviews were also completed.
Selection criteria: Only randomized control trials comparing a graded strengthening program with uni-dimensional or multi-dimensional programs were included.
Participants: 13 studies were identified for review including 517 subjects. The inclusion criteria specified that subjects must be adults with a confirmed diagnosis of stroke, and have received an evaluation on upper limb strength, upper limb function, or ADLs. To be included in the review, each study was required to have a clearly defined experimental and control group to distinguish between treatment types.
Intervention Investigated: For the purpose of this review, strength training was defined as, "An intervention that incorporated voluntary, active exercises against resistance" (Harris & Eng, 2009, p. 137).
Control: The control groups of the studies could be defined as receiving no treatment, placebo, or a non-strengthening intervention.
Experimental: The experimental groups of the studies had to include a component of strength or resistance training as an element of the intervention.
The majority of studies included a strength training intervention that utilized isotonic exercises with weights or resistance bands. The average treatment was one hour with an intensity of two to three days per week. The average duration of treatment was four weeks. However, four studies did have much longer treatment duration of 10 to 19 weeks.
Outcome Measures: The primary outcome measures of the review were upper limb strength, upper limb function, and upper limb function with ADLs. Upper limb strength was assessed by grip strength measurements. Upper limb function was assessed using the Motor Assessment Scale, the TEMPA, the Rivermead Motor Assessment, the Purdue Peg Board test, the Wolf Motor Function test, the Box and Block, the

Action Research Arm Test, and the Functional Test of the Hemiparetic Upper Extremity. The effect of strength training with the upper limb on ADLs was assessed using the Functional Independence Measure, the Barthel Index, and the SF-36 Physical Function Subscale.
Main Findings:
Grip strength**-**SMD 0.95; CI 95%; P=0.04; this outcome measure demonstrated a large effect size, indicating that strength training could be an effective treatment to remediate grip strength.
Upper limb function-SMD 0.21; CI 95%; P=0.03; this outcome measure demonstrated that strength training has a significant effect on upper limb function.
ADLs-SMD-0.26; CI 95%; P=0.16; this outcome measure did not indicate a significant effect for strength training of the upper limb with ADLs.
Original Authors' Conclusions: The findings from this meta-analysis indicate that strength training is an effective treatment to improve function without increasing tone or pain in individuals who have had a stroke (Harris & Eng, 2009, p. 139). Additional studies are necessary to determine the frequency, intensity, and type of strength training that is required to improve upper limb function in daily activities.

Critical Appraisal:
Validity: Holmes Level I, Strong meta-analysis
Interpretation of Results: The results of this meta-analysis indicated that grip strength and upper limb function were positively impacted by strength training. Only five of 13 studies in this analysis included ADLs as an outcome, and the pooled estimate of those five studies indicated that strength training did not improve performance with ADLs.
Summary/Conclusion: The findings from this meta-analysis support that strength training can improve upper limb function and grip strength, but may not be an effective treatment for improving function with ADLs.

Table 6: Description and appraisal of the systematic review of randomized control trials by Van der Lee, J. H., Snels, I., Beckerman, H., Lankhorst, G. J.
Objective of Systematic Review: The purpose of this study was to determine the effectiveness of exercise therapy to improve upper-limb function in adult post stroke.
Study Design: Systematic review
Search Strategy: The following databases were searched up to August 2000: Medline, Embase, CINAHL, the database of the Knowledge Centre for Professions Allied to Health, and the Database of the Cochrane Field 'Rehabilitation and Related Therapies'. The key search words included: Stoke, cerebrovascular disorders, hemiplegia, hemiparesis, upper extremity arm, rehabilitation, therapy, exercise therapy, physical therapy, physiotherapy, and occupational therapy.
Selection Criteria: The search was limited to: "studies concerning exercise therapy aimed at amelioration of the motor function of the hemiparetic/hemiplegic arm in stroke patients; only studies designed and reported as randomized clinical trials (RCTs); outcomes measured at impairment and/or disability level; separate results presented for the affected arm; published, full length articles; language: English, German, French, or Dutch; published after 1966" (Van der Lee, Snels, & Lankhorst, 2001, p. 21). There were a total of 15 articles included in the review, 13 RCTs were described.
Participants: The 13 RCTs in the review included 929 participants who were in the acute, subacute, or chronic stage of impairment following stroke. The participants were classified as having severe or mild to severe impairment in nine of the studies; whereas the majority of studies included mild to moderately impaired patients.

Intervention Investigated: The amount, duration, and type of exercise therapy provided differed between studies. However, every study included outcomes measured at impairment level and disability level.
Control: The groups that received a smaller amount or shorter duration of exercise treatment, or received a different type of intervention, or received no treatment.
Experimental: The groups that received a larger amount or longer duration of exercise treatment, or received the same amount and duration of exercise treatment, but received a different type of intervention.
Outcome Measures: The most frequently used outcome measures were the Barthel Index, the Action Research Arm test, and Fugl-Meyer assessment scale. For the purpose of this review, the authors summarized the result of each trial as either '+' or '0', with a '+' indicating a positive outcome for the experimental group or group receiving the greatest amount of exercise therapy, and a '0' indicating no difference between the experimental group and the control group.
Main Findings: In six of the 13 studies positive short term results were indicated for arm function tests. Of the 12 studies that included an ADL questionnaire, two reported positive results for the short term and long term follow up.
Original Authors' Conclusions: "The findings of this systematic review do not enable a definitive conclusion to be drawn about the effectiveness of exercise therapy to improve the arm motor function in stroke patients" (Van der Lee, Snels, & Lankhorst, 2001, p. 28). However, taking the results of this review in light of the conclusion of earlier reviews and meta-analyses, it is recommended that patients with stroke should be offered the opportunity to exercise the affected arm.

Critical Appraisal:
Validity: Holmes Level I; Moderate systematic review
Weakness: The main weakness of the review is the likelihood that the assessment of the study could be reproduced.
Interpretation of Results: The current review indicates that a definitive conclusion on the effectiveness of exercise therapy on arm function cannot be drawn, but that more intensive exercise in amount and duration of the affected upper limb may be beneficial to arm function.
Summary/Conclusion: Stroke patients should be encouraged to participate in exercise therapy following a stroke. While the evidence offers mixed results of effectiveness, this does not mean that there is no effect.

Table 7: Description and appraisal of the meta-analysis by French, B., Thomas, L. H., Leathley, M. J., Sutton, C. J., McAdam J., Forster, A., Langhorne, P., Price, C. I. M., Walker, A., & Watkins, C. L.
Objective of the Systematic Review: The objective of this review was to "determine if repetitive task training after stroke improves global, upper or lower limb function, and if treatment effects are dependent on the amount, type, or timing of practice" (French, et al., 2007, p. 1).
Study Design: Systematic review
Search Strategy: The following electronic databases were searched: the Cochrane Stroke Group Trials Register; the Cochrane Central Register of Controlled Trials; MEDLINE; EMBASE; CINAHL; AMED; SPORTDiscus; ISI Science Citation Index; Index to Theses; ZETOC; PEDro; OT Seeker; and OT Search. Searches were also included to identify further published, unpublished, and ongoing trials. Search terms were not mentioned.
Setting: Of the 14 trials included in this review, three were completed in Canada, three in Australia, three in the UK, one in Taiwan, one in the USA, one in the

Netherlands, one in Norway, and one in France. Four trials were in an inpatient setting, four trials were carried out in inpatient and outpatient care, four trials were in outpatient or community settings, and two trials were in the home environment.
Participants: There were 680 participants across the 14 trials. All trials included males and females, and the mean age ranged from less than 60 in two trials to over 70 in five trials. Mean time since stroke ranged from 14 days to the chronic phase of stroke
Intervention Investigated: Of the 17 interventions, seven were related to upper limb training. One trained functional reach in sitting and six were upper limb training. The comparisons included interventions against a control group getting no care and intervention against usual care. The number of hours of treatment varied from less than 10 hours to more than 40 hours. The duration of treatment varied as well from two weeks to over 20 weeks. All of the interventions were delivered by trained physiotherapists or occupational therapists with the exception of the home exercise programs that were self-monitored.
Outcome Measures: Primary outcome measures were upper limb function/ reach measured by arm function, hand function, and sitting balance/reach; lower limb function/balance measured by lower limb function, and standing balance/reach; and global motor function. The specific outcome measures for upper limb function/reach were the Motor Assessment Scale, the Action Research Arm Test, the Frenchay Arm Test, Wolf Motor Function Test, the Functional Test of the Hemiparetic Upper Extremity, Box and Block Test, and the Southern Motor Group Assessment. Hand function was measured using the Nine Hole Peg Test, the Ten Hole Peg Test, and the Motor Assessment Scale. Sitting balance and reach were assessed using the Sitting Equilibrium Index and the Motor Assessment Scale. The secondary outcomes included ADLs, quality of life, and impairment level measured by the Barthel Index, the Functional Independence Measure, the Modified Rankin Scale, the Global Dependency Scale, the Fugl-Meyer Assessment, the Dartmouth Primary Care Cooperative Chart, and the Nottingham Health Profile.
Main Findings:
Arm function-SMD 0.17; 95% CI -0.03 to 0.36; this outcome measure "indicated a small but marginally non-significant effect" (French, et al., 2007, p. 14).
Hand function-SMD 0.16; 95% CI -0.07 to 0.40; this outcome measure indicates a small and non-significant result.
Sitting balance/reach-SMD 0.23; 95% CI -.05 to 0.50; this outcome measure indicates a small and non-significant result.
ADL function-SMD 0.29; 95% CI 0.07 to 0.51; this outcome measure indicates a small effect size that is statistically significant.
Upper limb impairment-SMD 0.14; 95% CI -0.15 to 0.43; this outcome measure indicates a small effect size with no statistical significance.
Original Authors' Conclusions: The results of this review provided sufficient evidence to indicate that repetitive task training may result in modest improvement in lower limb function, but there was not enough clear evidence to make any recommendation for upper limb interventions.

Critical Appraisal:
Validity: Holmes Level I; Strong systematic review
Interpretation of Results: The trials included in this review did not provide evidence of the efficacy of repetitive task training for upper limb function. However, only three trials examined the evidence of the effect of more intensive therapy for the upper limb,

and the trials included participants of differing levels of ability. There were statistically significant results for ADLs, but not for quality of life or impairment measures.
Summary/Conclusion: In this review, repetitive task training did not provide any statistically significant results for upper limb function. However, the participants were at varying levels of ability and were at the acute and subacute stage of recovery. Therefore, this conclusion should be considered with these limitations in mind. Continuing research on the type, amount, and intensity of repetitive task training with participants with different clinical characteristics is necessary to draw further conclusions.

Table 8: Description and appraisal of the systematic review by Pomeroy, V., King, L., Pollock, A., Baily-Hallam, A., & Langhorne, P.
Aim/Objective of the Study/Systematic Review: To evaluate the effectiveness of electrostimulation on improving functional motor ability, and the ability to undertake activities of daily living.
Study Design: Meta-analysis
Search Strategy: The following databases were searched: Cochrane Stroke Group Trials Register, Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL, AMED, Physiotherapy Evidence Database (PEDro), REHABDATA and the ISI Science Citation Index. A request was placed on the PHYSIO e-mail discussion list and authors of relevant studies were contacted to elicit any unpublished or ongoing studies, searched the reference lists of included trials and contacted trialists
Selection Criteria: RCTs of electrostimulation delivered to the upper extremity to improve voluntary movement control, functional motor ability, and ADLs.
Participants: Twenty-four studies which identified 888 participants were included. Eight of the trials reported participant dropouts before outcomes could be assessed, leaving the total 835 participants from beginning to end. The mean age of the participants ranged from 52.05 to 76.50 years. Seventeen of the trials provided a mean time after stroke which ranged from 9.4 days to 4.29 years. Fourteen of the trials reported information about the side of hemiparesis in the experimental and control participants, with 54% having a left hemiparesis.
Intervention Investigated: The participants received electrostimulation to the neuromuscular system via electrodes which were placed either internally or externally on the affected extremity, with an ultimate goal of improving the voluntary movement control, functional motor ability and activities of daily living. The duration of the treatment varied from study to study, but ultimately occurred between one day and up to three months. The frequency ranged from one to five times a week while the intensity occurred from 10 minutes up to six hours a day.
Control: received an electrostimulation intervention combined with conventional therapy (non-elecrtostimulation)
Experimental: received the same type of conventional (non-electrostimulation) therapy, some received placebo electrostimulation treatment
Outcome Measures:
Primary: Focus on functional motor ability and the ability to undertake activities of daily living (ADL). Functional motor ability was assessed using: Rivermead Mobility Index, Walking Endurance, Timed Up and Go test, Motor Assessment Scale, Box and Blocks Test, Upper Extremity Drawing Test, Action Research Arm Test, Jebsen Hand Function Test, Nine Hole Peg Test, Barthel Index and Functional Independent Measure.

Secondary: Focus on motor impairment and the normality of movement. Motor impairment was assessed using: muscle tone, muscle function, joint range of active movement, physiological cost index and the Fugl-Meyer Assessment. Measures of normality of movement were assessed using: gait velocity, cadence, gait cycle time, stride length, minimum knee angle during swing phase, minimum ankle angle during swing phase, peak hip angle during swing phase, peak knee angle during swing phase, peak ankle angle during swing phase, timing of peak hip angle- per cent gait cycle, timing of peak knee angle- per cent gait cycle, timing of peak ankle angle- per cent gait cycle, and Motor Activity Log.
Main Findings: Electrostimulation compared with no treatment; statistically significant difference in favor of no treatment for functional motor ability upper extremity drawing test actual values and that electrostimulation improved motor impairment and functional motor ability. Electrostimulation compared with placebo; statistically significant differences between groups in favor of electrostimulation for functional motor ability (Jebsen Hand Function Test feeding and muscle function). Electrostimulation compared with conventional therapy; no statistically significant differences were found between groups for normality of movement, functional motor ability or global ADL. There was a statistically significant difference favoring estim for motor impairment on the Fugl-Meyer
Original Authors' Conclusions: The findings from this review indicate that there are some benefits for using electrostimulation for neuromuscular retraining after stroke in the areas of motor impairment and global ADLs, but that most of the benefits occurred when electrostimulation was combined with conventional therapy.

Critical Appraisal:
Validity: Holmes Level I; Moderate Systematic Review
Interpretation of Results: The current review indicates that whether or not electrostimuation should be used for neuromuscular retraining after stroke "cannot be answered with the data available at present" (Pomeroy, et al., 2009, p. 14).
Summary/Conclusion: Although there were limitations and biases related to the review, the most beneficial intervention for patients who had a stroke was to improve neuromuscular retraining using a treatment combination of electrostimulation and conventional therapy.

Table 9: Description and appraisal of the meta-analysis by Mehrholz, J., Platz, T., Kugler, J., & Pohl, M.
Aim/Objective of the Study/Systematic Review: To evaluate the effectiveness of electromechanical and robot-assisted arm training for improving activities of daily living, arm function and motor strength of patients after stroke and the acceptability and safety of therapy.
Study Design: Meta-analysis
Search Strategy: The following databases were searched: Cochrane Stroke Group Trials Register, Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL, AMED, PEDro, COMPENDEX and INSPEC, and hand searched relevant conference proceedings, searched trials and research registers, checked reference lists, and contacted trialists, experts and researchers in the field, and manufacturers of commercial devices.
Selection Criteria: Randomized control trials which compared electromechanical and robot-assisted arm training for recovery of arm function with other rehabilitation interventions or no treatment for patients after stroke. The searches were not limited by language, publication status or date.

Participants: Eleven trials made up of 328 participants were included in the review. Participants were both male and female and over the age of 18 who a diagnosis of a stroke. Some of the RCTs included in the review had a combination of diagnoses such as TBI and stroke, but they had to have more than 50% of the participants with a stroke.
Intervention Investigated: The participants received electromechanical and robot-assisted arm training with a variety of other interventions. The frequency of treatment was five times a week for all trials and intensity varied from 30 minutes to 90 minutes each work day.
Outcome Measures:
Primary- Focus on activities of daily living measured by the Barthel Index, the Functional Independence Measure, and the Stroke Impact Scale.
Secondary- Focus on impairments such as motor function and motor strength measured by the Fugl-Meyer Score and the Morticity Index Score.
Main Findings: No evidence was found to support that electromechanical assistive devices in rehabilitation settings may improve activities of daily living, and arm motor function and strength improved significantly.
Original Authors' Conclusions: The findings from this review indicate that there are some benefits for using electromechanical-assisted arm training after stroke in the areas of arm function and strength, but could not be compared to overall improvement in activities of daily living.

Critical Appraisal:
Validity: Holmes Level I; Strong Meta-analysis
Interpretation of Results: More benefits than not were found when using electromechanical assistive devices in stroke rehabilitation compared to no therapy.
Summary/Conclusion: More research needs to be done in this area, but electromechanical-assisted devices can aid in the recovery of stroke with the potential to increase the patients arm function and strength.

Table 10: Description and appraisal of the systematic review by Henderson, A., Korner-Bitensky, N., & Levin, M.
Aim/Objective of the Study/Systematic Review: To evaluate the effectiveness of virtual reality in upper limb motor recovery for patients who had a stroke.
Study Design: Systematic Review
Search Strategy: The following databases were searched: MEDLINE, EMBASE, CINAHL, PEDro, OT seeker, PsycINFO, Cochrane Database, CENTRAL, and Evidence-Based Review of Stroke Rehabilitation-Upper Limb Interventions were searched.
Selection Criteria: Randomized control trials, single-subject studies, and pre-post study designs which included 1) immersive or nonimmersive virtual reality (VR) in rehabilitation of the upper limb 2) adult patients with acute, subacute, or chronic hemiparesis 3) ischemic or hemorrhagic stroke 4) had an element of retraining of arm movements.
Participants: There were 96 participants across the six studies included and the time since stroke ranged from acute to chronic.
Intervention Investigated: Immersive and nonimmersive interventions were compared to no therapy or conventional therapy. Frequency and duration varied from 1 hour/day, for 4 weeks to 16 sessions spaced over 11-13 weeks.
Outcome Measures: Box and Blocks Test, Fugl-Meyer Arm Scale, Manual Function Test, FIM, Structured Assessment of Independent Living Skills, and the Wolf Motor Function Test.

Main Findings: In the study of immersive VR vs. conventional therapy or no therapy; improvements were seen in manual dexterity, grip force, and control of the affected upper limb in one subject after training. In a comparison of nonimmersive VR vs. conventional therapy or no therapy; 1 RCT reported no significant difference in FM and FIM scores in the 24 subjects included. The pre-post design studies found significant changes in FM and FIM scores as well as reaching duration and velocity compared to baseline scores.
Original Authors' Conclusions: The findings from this review indicate that immersive virtual reality has more benefit in the recovery of upper limb function in stroke patients than no therapy, and that nonimmersive VR has conflicting results and is thus questionable.

Critical Appraisal:
Validity: Holmes Level I; Strong Systematic Review
Interpretation of Results: The current review indicates that using immersive virtual reality in rehabilitation has shown improvements in areas such as manual dexterity and grip force.
Summary/Conclusion: Although there are limitations in this review such as small sample sizes and issues with validity of the studies included, overall it shows benefit from virtual reality treatment. More research needs to be done to expand on the effectiveness of this type of treatment.

Table 11: Description and appraisal of the randomized controlled trail with a blinded observer by Dromerick, A.W., Edwards, D.F., Hahn, M.
Objective of the Study: The aim of the study was to determine if Constraint-Induced movement therapy is more effective than routine therapies of the upper-extremity.
Study Design: A prospective RCT with a blinded observer to measure baseline and a repeat measure at 14 day interval of the Total Action Research Arm Test, Barthel Index, and Functional Independence Measure.
Setting: 32- bed inpatient rehab unit for stroke and brain injury rehabilitation services.
Participants: 23 people enrolled in the study and 20 completed the 14 day treatment. The age range was 47-83 years old and consisted of both females and males.
Intervention Investigated: The control group and experimental group both received treatment for 2 hours per day, 5 days per week, for 2 consecutive weeks.
Control: The control group received traditional occupational therapy that consisted of compensatory techniques for ADLs, UE strengthening and ROM.
Experimental: The experimental group received constraint-induced movement therapy that maximized subject's attention and effort toward the hemiparetic UE.
Outcome Measures: The primary measure was the Action Research Arm Test. The secondary measures were the Barthel Index and Functional Independence Measure by a blinded occupational therapist at baseline and at 14 days.
Main Findings: The mean score on the Action Research Arm Test was significantly higher in the experimental group after 14 days of treatment. The mean score on the Functional Independence Measures of the UE dressing at discharge was higher in the experimental group.
Original Authors' Conclusions: The forced use of the hemiparetic UE during the acute rehabilitation phase of recovery increases occupational performance skills.

Critical Appraisal:
Validity: Holm's Level II, Strong AACPDM rating.
Interpretation of Results: The implementation of Constraint-Induced Movement Therapy during the acute phase of rehabilitation has measurable positive results on the client's occupational performance skills.

Summary/Conclusion: Occupational therapist should strongly consider implementation of Constraint-Induced Movement Therapy on post CVA clients to improve functional performance of the hemiparetic UE.

Table 12: Description and appraisal of the quasi-experimental design by Gibson, J. W., & Schkade.
Objective of the study: The aim of the study was to evaluate the use of the Occupational Adaptation frame of reference in treatment of CVA clients.
Study Design: The quasi-experimental design was used to measure functional independence and discharge environment. The study used sample of convenience.
Setting: 465 bed metropolitan hospital with a diverse client population.
Participants: 50 patients or former patients with a mean age 73.5 -74.7 years old for both control and experimental group.
Intervention Investigated: The control was selected through review the charts of patients with CVA recently discharged until 25 met the inclusion criteria. The Experimental group was made up of current patients who met the inclusion criteria.
Control: The control group received traditional therapy interventions focused on improving patients functional deficits identified in the initial evaluation.
Experimental: The experimental group received therapy that was driven by the occupational adaptation frame of reference. The therapist had to identify the patient's role and abilities. The therapist than had to facilitate the patients abilities to meet the demand of the role requirements.
Outcome Measures: A facility generated functional independence measure was used in the study. The facility generated functional independence measure used a six point ordinal scale that asses ADL. The scale levels include independent, standby assistance, minimum, moderate, maximum, and dependent.
Main Findings: Increase in functional independence in the experimental group..
Original Authors' Conclusions: The implementation of the occupational adaptation frame of reference is at least associated with increase functional independence at discharge.

Critical Appraisal:
Validity: Holm's Level III, Weak AACPDM rating
Interpretation of Results: The occupational adaptation frame of reference is associated with increase functional independence at discharge but this may be due to learned non use of the affect limb.
Summary/Conclusion: The occupational adaptation frame of reference when implemented with the CVA population needs further research before a positive conclusion can be reach due to several limitations of the study.

Table 13: Description and appraisal of the Pre-Post Test design by Van Heughten, C.M., Dekker, J., Van Dijk, A., et al.
Objective of the Study: The evaluation of strategy training for stroke patients with apraxia.
Study Design: The study was a pre-post test design that took measurements at baseline and 12 weeks.
Setting: Hospitals, nursing homes, and rehabilitation units across the Netherlands.
Participants: 45 patients male and female with a mean age of 70.1. 23 patients had cerebral infraction, 9 patients had cerebral haemorrhage, 1 unknown.
Intervention Investigated: The interventions were built in a hierarchical order based on Instructions, Assistance, and Feedback.

. The therapist could determine the patient's level of functions and give the intervention in the appropriate tier. The interventions consisted of focus on the tier where the greatest deficits occurred. **Outcome Measures**: Three outcome measures were used: standardized ADL observations, Barthel Index, and ADL questionnaire. There was16 occupational therapists that administered the assessments. Two measures had no psychometric properties. **Main Findings:** The results of the study showed significant improvement on ADL function on all outcome measures. **Original Authors' Conclusions**: The study showed that by providing a programme that teaches patients compensatory strategies to help manage their apraxia would able the patients to achieve function more independently.
Critical Appraisal: **Validity**: Holm's Level III, Moderate AACPDM rating **Interpretation of Results**: The results showed that by implementing a compensatory strategy training program that patients can be successful in managing their apraxia. The results suggest that further research is needed since there was no control group to compare. **Summary/Conclusion:** The occupational therapist should consider a hierarchical order of compensatory interventions to help stroke patients manage their apraxia so they may function more independently.

Table 15: Characteristics of included studies

	Study 1 (Luke, Dodd, & Brock, 2004)	**Study 2 (Hakkennes & Keating, 2005)**	**Study 3 (Van der lee, Lankhorst, Vogelaar, Deville, & Bouter, 1999)**	**Study 4 (Harris & Eng, 2009)**	**Study 5 (French, et al., 2007)**
Intervention investigated	Bobath concept	CIMT	CIMT	Strength training	Exercise therapy
Comparison intervention	Bobath concept vs.Proprioceptive Neuromuscular Facilitation, repetitive tasks, and cryotherapy	NA	NDT	Strength training vs. Placebo; no treatment; or non strengthening intervention	Exercise therapy vs. lower amount of exercise therapy; placebo short wave therapy; sensorimotor experience with robotic device
Outcomes used	ICF domains of participation, impairment, and activity limitation	Outcome measures were different in each trial;	RAP, ARA, FMA, & MAL	Grip strength; Upper limb function; and ADLs	Barthel Index; Action Research Arm Test; and the Fugl-Meyer

		however the Motor Activity Log was used in 14 of the 18 included studies			
Findings	There were significant results found in the impairment domain, but effects were inconclusive in the activity limitation and participation domains.	CIMT may improve upper limb function post CVA. Evidence did not support that CIMT effected patient's quality of life & independence in ADLs	Small lasting effects were found in CIMT. These results were not found to be significant in ADL outcome measures.	Strength training can improve upper limb function and grip strength, but may not be an effective treatment for improving function with ADLs.	A definitive conclusion could not be drawn on the effectiveness of exercise therapy to improve the arm motor function.

	Study 6 (Van der Lee, et al., 2001)	**Study 7 (Pomeroy, et al., 2009)**	**Study 8 (Mehrholz, et al., 2009)**	**Study 9 (Henderson, et al., 2007)**
Intervention investigated	Repetitive task training	Electrostimulation	Electromechanical and robot-assisted arm training	Virtual Reality
Comparison intervention	Repetitive task training vs. usual practice; no treatment; or an attention control group (participation activity with no motor benefits)	Electrostimulation vs. no treatment; placebo; conventional therapy; different types of electrostimulation	Electromechanical and robot-assisted arm training vs. a variety of other interventions	Immersive virtual reality vs. conventional therapy; no therapy; or nonimmersive virtual reality vs. conventional therapy; no therapy
Outcomes used	Upper limb function/reach; ADL measures; QOL measures	Assessments focused on motor ability, the ability to undertake ADLs, motor impairment, and the normality of movement	Barthel Index; FIM; Stroke Impact Scale; Fugl-Meyer; Morticity Index Scale	Box and Blocks Test; Fugl-Meyer; Manual Function Test; FIM; Structured Assessment of Independent Living Skills; Wolf Motor Function Test

Findings	No statistically significant differences for hand/arm function or QOL measures. There were statistically significant results for ADLs.	Improvements seen in functional motor ability and a decrease in motor impairment.	Improvements seen in arm function and strength, but may not improve function of ADLs.	Improvements seen in manual dexterity and grip force with immersive virtual reality, but may not improve function of ADLs.

	Study 10 (Dromerick, et. al., 2000)	**Study11 (Gibson & Schkade, 1997)**	**Study 12 (Van Heugten, et. al., 1998)**
Intervention investigated	CIMT	OA frame of reference	Compensatory strategies for apraxia
Comparison intervention	Traditional Occupational Therapy	Traditional Occupational Therapy	NA
Outcomes used	ARA, BI, FIM	facility generated functional independence measure	standardized ADL observations, Barthel Index, and ADL questionnaire
Findings	CIMT group has improved ARA score and FIM mean score	OA group had increase mean score on the functional independence measure	significant improvement on ADL function

IMPLICATIONS FOR PRACTICE, EDUCATION and FUTURE RESEARCH

There is a body of evidence investigaing various remedial therapies. Some have growing bodies of evidence (Constraint-induced and strengthening therapies) while others are new interventions (virtual reality, robotics). Some therapies have limited evidence to support their efficacy (NDT/Bobath). The common theme for remedial therapy across all intervention strategies is the need for further research to determine the minimum intensity and duration necessary for maximum restoration of function. While research on compensatory strategies is extremely limited it is still part of the recovery process. Research is needed to determine at what point it is most beneficial in the recovery process to consider integrating a compensatory approach in combination with remedial therapy.

The entry level educational process should include formal training on both remedial and compensatory strategies. Experienced clinicians growing and sharing their knowledge of the most effective techniques of compensatory strategies would enhance the evidence base of this type of therapy. Continuing education programs should focus on interventions that have evidence to support their use.

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