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REVIEW PAPER

Task-oriented training in rehabilitation after stroke: systematic review

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Abstract

Title. Task-oriented training in rehabilitation after stroke: systematic review.

Aim. This paper is a report of a review conducted to provide an overview of the evidence in the literature on task-oriented training of stroke survivors and its relevance in daily nursing practice.

Background. Stroke is the second leading cause of death and one of the leading causes of adult disability in the Western world. The use of neurodevelopmental treatment in the daily nursing care of stroke survivors does not improve clinical outcomes. Nurses are therefore exploring other forms of rehabilitation intervention, including task-oriented rehabilitation. Despite the growing number of studies showing evidence on task-oriented interventions, recommendations for daily nursing practice are lacking.

Data Sources. A range of databases was searched to identify papers addressing task-oriented training in stroke rehabilitation, including Medline, CINAHL, Embase and the Cochrane Library of systematic reviews. Papers published in English between January 1996 and September 2007 were included. There were 42 papers in the final dataset, including nine systematic reviews.

Review methods. The selected randomized controlled trials and systematic reviews were assessed for quality. Important characteristics and outcomes were extracted and summarized.

Results. Studies of task-related training showed benefits for functional outcome compared with traditional therapies. Active use of task-oriented training with stroke survivors will lead to improvements in functional outcomes and overall health-related quality of life.

Conclusion. Generally, task-oriented rehabilitation proved to be more effective. Many interventions are feasible for nurses and can be performed in a ward or at home. Nurses can and should play an important role in creating opportunities to practise meaningful functional tasks outside of regular therapy sessions.

Keywords: literature review, nursing, rehabilitation, stroke, task-oriented training

Introduction

Stroke is the second leading cause of death and one of the leading causes of adult disability in the Western world today. In the Netherlands it is estimated that the incidence of stroke will increase from 1·8 per 1000 inhabitants in 2000 to 2·8 per 1000 in 2020 (Struijs *et al.* 2005).

Stroke rehabilitation is an organized endeavour to help patients to maximize all opportunities for returning to an active lifestyle (Gresham *et al.* 1997, Aichner *et al.* 2002). Neuro-rehabilitation is a method for relearning a previously learned task in a different way, either by compensatory strategies or by adaptively recruiting alternative pathways (Matthews *et al.* 2004). Rehabilitation nursing focuses on assisting people with a disability or chronic illness to attain maximum functional ability, maintain optimal health and adapt to an altered lifestyle (Barker 2002). While stroke is an important cause of disability, there is no generally accepted method for rehabilitating stroke survivors. Commonly-used treatment approaches that focus on impairments and seek to regain a 'normal' movement pattern, such as neurodevelopmental treatment (NDT), have proved ineffective (Pomeroy & Tallis 2000, Paci 2003, Hafsteinsdottir *et al.* 2005, Kollen *et al.* 2006, Lennon *et al.* 2006).

During the past two decades, major progress in neuroscience has resulted in novel concepts for rehabilitation interventions after stroke. Various studies support the choice of task-oriented training. Neuro-imaging studies in animals and humans have provided strong evidence for changed activation patterns in many parts of the damaged brain (Turkstra *et al.* 2003, Kleim *et al.* 2004, Nudo 2007). In addition, movement and experience-dependent reorganization patterns have been observed in both the damaged hemisphere and the contralateral hemisphere (Johansen-Berg *et al.* 2002, Jang *et al.* 2003, Liepert *et al.* 2004, Lindberg *et al.* 2004, Luft *et al.* 2004, Ward 2007). There are strong indications that functional recovery is not only the result of restoration from impairments. Adaptation strategies to compensate for the impairments also contribute (Kwakkel *et al.* 2004a).

Definition of task-related training

Unfortunately, no conclusive definition of a task-oriented approach exists in the literature. In the task-oriented approach, *movement* emerges as an interaction between many systems in the brain and is organized around a goal and constrained by the environment (Shumway Cook & Woollacott 2001). Task-oriented training includes a wide range of interventions such as treadmill training, walking training on the ground, bicycling programmes, endurance training and circuit training, sit-to-stand exercises, and reaching tasks for improving balance. In addition, use is made of arm training using functional tasks such as grasping objects, constraint-induced (movement) therapy (CIMT) and mental imagery. Such training is task and patient focused and not therapist focused.

As well as the content of the therapy, the optimal amount of therapy needed for patients after stroke is not exactly known. The time spent in exercise programmes is often decided pragmatically and is not based on the time necessary to learn a given skill (Kwakkel 2006). In a systematic review of the effects of therapy intensity it was concluded that augmented therapy input of at least 16 hours a week has a favourable effect on the improvement of activities of daily living (ADL) (Kwakkel *et al.* 2004b). However, nurses provide continuous and coordinated care to stroke survivors 24 hours a day, 7 days a week and could play an important role in the relearning process. A well-coordinated and organized multidisciplinary rehabilitation programme, beginning as soon as possible after stroke, is important for an effective stroke unit (Indredavik *et al.* 1999, Langhorne & Pollock 2002). Therefore, nurses are key members of the stroke team and their input is essential for achieving set rehabilitation goals (Long *et al.* 2003). In other words, nurses play an essential role in coordinating care and bridging the gap between disciplines (Strasser *et al.* 2005).

The review

Aim

The aim of the present study is to provide an overview of the evidence in the literature on task-oriented training of stroke survivors and its relevance in daily nursing practice.

Design

Literature was systematically reviewed following the steps of the QUORUM statement (Moher *et al.* 1999) and the Cochrane Handbook for Systematic Reviews (Higgins *et al.* 2005).

Search methods

First, the databases Medline, Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Embase were searched using the following key terms: stroke (MeSH term) and cerebrovascular accident (MeSH term), combined with task-related training and task-oriented training. Those two terms were combined with activities of daily living, posture, arm, walking and physical condition (MeSH terms) and with the non-MeSH terms balance, balance exercise, sit to stand, gait, constraint-induced movement therapy and mental practice.

Inclusion criteria

- Types of participant: stroke survivors in the acute phase, the rehabilitation phase and the chronic phase.
- Type of event: ischemic and haemorrhagic stroke.
- Types of outcome measure: outcomes of interventions are focused on functional performance and/or activities of daily living. Studies comparing clinical outcome measures with laboratory tests are also analyzed.
- Publication date: published in English between January 1996 and September 2007.
- Review design: meta-analysis, systematic reviews and randomized controlled trials.
- Types of intervention: Only studies with interventions aimed at task-oriented exercises that are feasible and suitable for daily nursing practice in a stroke ward or at home with minimal technical equipment were selected. The intervention needed to be congruent with the definition of the Nursing Interventions Classification (McCloskey & Bulecheck 2000): a nursing rehabilitation intervention is 'any treatment based upon clinical judgment and knowledge that a nurse performs to enhance patient outcomes' (p19). Interventions aimed towards the following domains were considered:
  - o Balance exercise, i.e. use of specific activities and movements to maintain, enhance or restore balance (McCloskey & Bulecheck 2000). Task-oriented training involves reaching towards objects placed across a table, and providing an implicit exercise to improve symmetrical weight distribution over both legs (Mudie *et al.* 2002, Dean *et al.* 2007) .
  - o Ambulation exercise: promotion and assistance with walking to maintain or restore autonomic and voluntary body functions (McCloskey & Bulecheck 2000). Walking training is often performed on a treadmill, with or without body weight support. In the present survey, only studies in which one of the interventions was walking on the ground were analysed.
  - o Strength training: facilitation of regular resistive muscle training to maintain or increase muscle strength (McCloskey & Bulecheck 2000).
  - o Exercise promotion: facilitation of regular physical exercise to maintain or advance to a higher level of fitness and health (McCloskey & Bulecheck 2000).
  - o Arm-training*:* This includes CIMT. CIMT has three components: restraint of the less impaired arm, training functional tasks repetitively and a package of behavioural techniques with emphasis on immediate encouraging feedback when patients make even a small gain (Uswatte *et al.* 2006). Use of functional tasks makes CIMT a good example of task-oriented training.
  - o Mental practice*:* Mental practice or mental imagery is a technique in which a skill is mentally rehearsed in a repetitive manner without any visible movement or muscle activation (Mulder 2007).

Search outcome

The initial search strategy generated 1506 papers. The first author evaluated the titles and 563 articles were found to fit the inclusion criteria. Of these, 147 abstracts were included for further examination. At the final stage, studies included in published reviews were not counted separately, with exception of three papers on walking training.

Quality appraisal

Inclusion in the final sample was guided by the methodological quality of the 147 studies selected, which were exclusively randomized controlled trials (RCT). This quality was evaluated independently by two authors, using the Delphi Criteria List (Verhagen *et al.* 1998). The quality of the systematic reviews was evaluated using the criteria described by Grimshaw *et al.* (2003). In the final dataset, nine systematic reviews (including only RCTs) and 33 RCTs were included (Figure 1). Papers included in the systematic reviews were not analysed separately, with exception of three papers on walking training (Dean *et al.* 2000, Blennerhassett & Dite

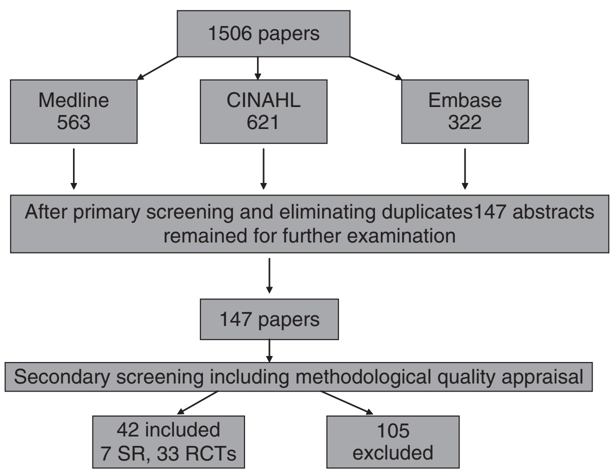

Figure 1 The screening process.

2004, Salbach *et al.* 2004), which were also included in the review by Van de Port *et al.* (2007).

Data abstraction

The following study characteristics were recorded on a data extraction form: setting and phase, study design and population, intervention, outcome and measurement. For the systematic reviews the intervention, the number of studies included and the conclusion were extracted (Tables 1 and 2).

Synthesis

The studies included differed markedly with regard to interventions, methodology, outcome measures, patient characteristics and methodological quality. Also, the phase after stroke and the setting of the study differed. Eleven studies were performed in the (sub)-acute phase, the other 22 in the chronic phase. Because of these differences it was not possible to conduct meta-analyses pooling the results of the various task-oriented training interventions, and so the findings are reported using a narrative summary technique.

Results

Material from the literature is organized below in a way similar to previously-published guidelines for stroke rehabilitation (Teasell *et al.* 2006), starting with balance training and proceeding to sitting and reaching, sit to stand training, gait training and interventions for physical fitness. In the final part, we describe the results of arm training and conclude with mental imagery practice.

Balance training

A systematic review showed that there is insufficient evidence that one intervention or approach is more effective than another in improving balance recovery among stroke survivors (Pollock *et al.* 2007). In the present investigation, three small studies of good quality focusing on task-oriented exercises and using functional outcome measures were identified and reviewed. The effect of cycling training on balance in sub-acute phase patients was measured by Katz-Leurer ($n = 24$). The exercise group, who had a daily cycling session in addition to the usual therapy, maintained balance better under different conditions. There was no follow-up after 6 months (Katz-Leurer *et al.* 2006). The other two studies were performed with patients in the chronic phase. In one study ($n = 16$) the effects on stroke survivors of a task-oriented exercise programme were compared with altered sensory input. Tasks were performed on different surfaces with eyes closed or open. Those receiving exercise assisted by sensory manipulation improved statistically significantly ($P < 0{\cdot}05$) in standing balance, but the effect did not extend to walking (Bayouk *et al.* 2006). Patients ($n = 30$) in the group trained with an agility exercise programme showed greater improvement in step reaction time and had fewer falls when balance was challenged. The agility exercise programme halved the number of patients who fell during the follow-up after 1 year (Marigold *et al.* 2005).

Two studies focusing on perceptual learning were identified. Both were well performed but the samples were small and there was no follow-up. Patients in the sub-acute phase ($n = 12$) were trained to discriminate the hardness of different pieces of sponge rubber placed under the sole of the foot. Balance (body sway) improved statistically significantly ($P = 0{\cdot}001$) in the experimental group. Improvement of clinical standing balance was not determined (Morioka & Yagi 2003). In the second study, long-term survivors ($n = 20$) received balance training with visual deprivation. Laboratory measurements of balance under six conditions improved more in the vision-deprived than in the free-vision group. Also, gait velocity and timed stair climbing correlated statistically significantly with improved balance ($P = 0{\cdot}01$, $P = 0{\cdot}04$) (Bonan *et al.* 2004).

Balance training focused on balance parameters did not generalize to functional improvement. Balance training needs to be practised in relation to a task (Bayouk *et al.* 2006).

Sitting and reaching

Eight studies of moderate quality were found that focused on sitting and reaching. One study performed in the sub-acute phase after stroke showed no differences in symmetric weight bearing between a group of patients practising several reaching tasks independently and a group receiving the usual care (Pollock *et al.* 2002). A training programme with lateral weight transference exercises did not enhance functional outcome (Howe *et al.* 2005). Balance feedback training and task-specific training improved symmetrical weight distribution in patients (Mudie *et al.* 2002). In a small study ($n = 12$) of patients in the chronic phase, task-related training was more beneficial than resistance training for patients' functioning on a lower level (Thielman *et al.* 2004). In two small studies in the sub-acute and chronic phases ($n = 20$, $n = 12$, respectively), sitting balance improved after practice, resulting in better and further reaching and faster standing up. There was, however, no carry-over to walking (Dean &

Table 1 Characteristics of the systematic reviews included in the review

References	Intervention	Number of studies	Conclusion
van der Lee *et al.* 2001	Exercise therapy for arm function in stroke survivors	15 trials out of 72. 13 RCTs n = 939	No statistical pooling. Insufficient evidence to draw conclusions about the effectiveness of exercise on arm function. There is a suggestion that more therapy is beneficial
Van Peppen *et al.* (2004)	Impact of physical therapy on functional outcomes after stroke	151 studies, 123 RCTs and 28 CCT	Strong evidence in favour of task-oriented training to restore balance and gait and for strengthening the paretic limb. SES high intensity exercise training 0·13 95% CI 0·03–0·23. Insufficient evidence in functional outcome for traditional neurological treatment approaches
Saunders *et al.* (2004) Cochrane review	Physical fitness training for stroke survivors	12 trials, Total n = 289	Statistically significant improvement was observed only in FAC scores and max. walking speed after walking training, standardized mean diff. 0·42 m/s 95% CI 0·04–0·79. Any training induced benefit appear to be associated with specific or task-related training
Pang *et al.* (2006a)	Exercise training using as an outcome peak oxygen consumption and walking velocity and endurance	Seven studies (RCT) out of 29, n = 13–157	Statistically significant effect size in favour of aerobic exercise to improve peak V_{O2} . (SES 0·42 95% CI 0·15–0·69, P = 0·001) and in favour to improve walking velocity and endurance (SES 0·30 95% CI 0·06–0·55 P = 0·008)
Pollock *et al.* (2007), Cochrane review	Physiotherapy treatment approaches for the recovery of postural control and lower limb function following stroke	21 studies out of 265, Total n = 1087	Insufficient evidence to conclude that one approach is more effective in promoting lower limb function or postural control than another approach Limited evidence that using a mix of components from different approaches is more beneficial than no treatment or placebo. Standardized mean diff. SMD 0·94 95% CI 0·08–1·80
Ada *et al.* (2006)	Strengthening interventions including progressive resistance exercise	15 trials out of 102, Total n = 359	Strengthening interventions had a small pos. effect on both strength (standardized mean diff. SMD 0·33 95%CI 0·13–0·54) and activity (SMD 0·32 95%CI 0·11–0·53). No effect on spasticity.
Van de Port *et al.* (2007)	Exercise training programmes on walking competency after stroke	12 studies out of 246 studies, Total n = 501	Strong evidence was found for improved functional mobility after gait-oriented training (SES fixed 0·45 CI 0·27–0·63) Findings provide strong evidence that standing balance, (I) ADL or QoL not statistically significant more improved than by conventional care.
Bohannon (2007)	Muscle strength and muscle training of the lower limbs after stroke	Search identified 3 SRs, 5 RCTs and 7 other studies	No statistical pooling. The ability of strengthening to enhance the performance of functional activities or participation remains uncertain, except perhaps regimens involving repeated sit to stand or step up manoeuvres.
Bonaiuti *et al.* (2007)	The constraint induced therapy on adult stroke survivors	9 out of 13 RCTs Total n = 243	Statistical differences could not been measured Minimal clinical importance was defined as a change at least 10% change of the maximum score of a test. Studies suggest an effectiveness but samples are too small and there is no homogeneity

RCT, randomized controlled trial; CCT, controlled clinical trial; SR, systematic review; SES, summary effect size; CI, confidence interval; FAC, functional ambulation categories; (I)ADL, (instrumental) activities of daily living; QoL, quality of life.

Shepherd 1997, Dean *et al.* 2007). Two studies showed that restriction of trunk movements with reach and grasp training led to further arm reaching with diminished trunk bending while grasping an object (Michaelsen & Levin 2004, Michaelsen *et al.* 2006). Both studies were performed with patients in the chronic phase after stroke.

Table 2 Characteristics of the studies included in the review

References	Setting/phase	Sample	Study design	Intervention	Outcome/measures	Results and conclusion
Balance						
Marigold *et al.* (2005)	Community chronic phase	$n = 61$	RCT 2 groups, 2 interventions	1. Agility training 2. Stretching/weight shifting 3 times/week/1 hour/10 weeks 1 supervisor/3 participants	BBS, TUG, step reaction time, ABC, NHP, induced falls on a platform	Exercise led to improvement in all clinical outcome measures in both groups (trend towards statistical significance). Group-by-time interaction, $P = 0{\cdot}04$. Group exercise improves functional balance
Katz-Leurer *et al.* (2006)	Rehabilitation Department Sub acute phase	$n = 24$	RCT Exp. $n = 10$	6 weeks usual rehabilitation Experimental group: cycling programme, during 3 weeks daily	Standing balance PASS Fugl Meyer	Both groups improved statistically significantly on PASS and Fugl Meyer with a statistically significant group-time interaction effect ($P < 0{\cdot}01$) on the PASS and FM score
Bayouk *et al.* (2006)	Discharged home ≥ 6 months post stroke	$n = 16$	RCT Exp. $n = 8$	8 week task oriented exercise on balance and mobility. Exp. plus. manipulation poprioception of feet and ankles and/or vision	1. Measurement COP displacement under 4 sensory conditions. 2. 10 m walking test	Both groups improved statistically significantly on the 10 m walking test ($< P\ 0{\cdot}05$). Exp. group performed better in standing double legged with eyes open on a normal and soft surface ($P < 0{\cdot}05$)
Balance/perception training						
Morioka and Yagi (2003)	Hospital Sub-acute phase	$n = 28$	RCT Exp. $n = 12$	Hardness discrimination using three different levels of hardness (5 mm–15 mm) of sponge rubber placed under the sole of the foot (10 days)	Postural sway by a stabilometer, eyes open and eyes closed.	Incorrect answers in testing the hardness, decreased ($P = 0{\cdot}001$). No differences in two point discrimination was found between groups. Difference in postural sway parameters was statistically significant
Bonan *et al.* (2004)	Discharged home chronic ≥ 12 months post stroke	$n = 20$	Single blinded RCT Exp. $n = 10$	Rehabilitation programme for both groups, except that the eyes of the vision deprived group were blinded with a mask	Balance (laboratory test 6 sensory conditions). Gait velocity, timed stair climbing and walking	In all six sensory conditions the gain in the experimental group was greater (sign. $P = 0{\cdot}01$ and $P = 0{\cdot}04$, in 2 conditions). Gain in balance correlated with gait velocity ($P = 0{\cdot}03$), timed stair climbing ($P = 0{\cdot}01$)
Sitting and reaching						
Dean and Shepherd (1997)	Community ≥ 12 months after stroke	$n = 20$	RCT Exp. $n = 10$	10 sessions in 2 weeks at home, reaching beyond arm length Control: sham training	Muscle strength limb, sit to stand, walking, 'reach to grasp and drink a glass of water'	Experimental group reached further and faster, increased activation of the affected leg muscles ($P < 0{\cdot}001$) No difference in walking distance

Table 2 (*Continued*)

References	Setting/phase	Sample	Study design	Intervention	Outcome/measures	Results and conclusion
Pollock *et al.* (2002)	Hospital sub-acute phase < 6 weeks poststroke	$n = 28$	RCT Exp. $n = 9$	Exp. special designed protocol: construction tasks and stacking tasks, during 4 weeks Both groups Bobath	Achieving normal symmetry of weight distribution measured with a force platform	No clinically significant differences between the groups. The regime of independent practice had no measured beneficial effect on the weight distribution
Mudie *et al.* (2002)	Rehabilitation Unit sub-acute phase	$n = 40$	RCT 4 groups $n = 4 \times 10$	1. task specific reach, 2. Bobath 3. balance, 4. no specific training. 2 weeks daily sessions. Follow-up after 12 weeks	Symmetry of weight distribution measured with the balance perfomance monitor	At 12 weeks: 83% of the balance group, 38% of the task specific reaching group, 29% of the Bobath group, 0% of the untrained group distribute their weight to both sides
Thielman *et al.* (2004)	Home 5–12 months discharged from rehabilitation	$n = 12$	RCT $n = 2 \times 6$	Training paretic limb 1. Training task related 2. progressive resistance4 weeks/ 12×35 min/150–180 movements/session	Kinematic analysis arm and trunk, MAS and Rivermead (RM)	No statistical significant effect for the MAS. Low level patients showed better performance
Michaelsen and Levin (2004)	Home chronic 7–94 months poststroke	$n = 28$	RCT Exp. $n = 14$	Grasping a cilinder with no trunk moving. Exp: restriction of trunk movements by a harnass. 1 single session	1. Fugl Meyer Arm 2. Upper Extremity performance test for the elderly (TEMPA)	Trunkrestraint group: more elbow extension, less anterior trunk displacement (group main effect $F = 5{\cdot}14$, $P < 0{\cdot}05$) and better interjoint coordination
Howe *et al.* (2005)	Hospital acute phase	$n = 35$	RCT Exp. $n = 17$	Usual care plus exp: Exercises lateral weight transference in sitting 12 sessions/4 weeks	Dynamic reaching, sitting and standing. (timed standing up) Static standing balance	No differences between groups. Lateral weight transference did not appear to enhance the functional rehabilitation of patients in the acute phase
Michaelsen *et al.* (2006)	Community chronic 6–48 months after stroke	$n = 30$	RCT Exp. $n = 15$	Supervised home programme Exp: progressive reach to grasp with prevention of trunk movements (TR) 3×/week/5 weeks	1. Fugl Meyer, 2. movement kinematics 3. TEMPA. Follow-up after 1 month	Experimental group: greater improvement in impairment FM $P < 0{\cdot}035$, and function TEMPA $P < 0{\cdot}05$. Increased joint range . More severe patients, more effect
Dean *et al.* (2007)	Hospital < 3 months poststroke	$n = 12$	RCT	Exp. sitting training protocol as in the study in 1997 Control: sham training	Same tests as study in 1997: Movement time, reaching test, muscle strength affected leg, sit to stand and walking	Maximal reach distance increased 0·17 m (95% CI 0·12–0·21). Force foot increased 21%. Sitting training early after stroke improves sitting ability and carries over to standing up but not to walking
Sit to stand						
Cheng *et al.* (2001)	Rehabilitation unit sub-acute phase	$n = 54$	RCT Exp. $n = 30$	Exp. Conventional stroke rehabilitation and symmetrical sit to standing training	Assessing sit to stand. Occurrence of falls in the two groups	Statistically significant improvement in training group in the sit to stand performance. After 6 months less fallincidents ($P < 0.05$)

Table 2 (*Continued*)

References	Setting/phase	Sample	Study design	Intervention	Outcome/measures	Results and conclusion
Walking						
Dean *et al.* (2000)	Rehabilitation Center ≥ 3 months poststroke	$n = 12$	RCT convenience sample Exp. $n = 6$	Exp. strengthening affected limb and practicing functional tasks in a circuit training. Control: upper limb tasks 4 weeks/3×/week, 1 hour	Walking speed and endurance, peak vertical ground reaction force and step test	Statistically significant improvement in the experimental group ($P = \leq 0.05$) on all the outcome measures.
Blennerhassett and Dite (2004)	Rehabilitation Center sub-acute phase	$n = 30$	RCT single blinded clinical trial Exp. $n = 15$	Exp. extra training functional tasks in a circuit of ten tasks. Control: upper limb training functional tasks 4 weeks/1 hour a day	TUG, Step test and 6 Minute Walking tets Arm: the Jebsen Tayler Hand Function test and the MAS	Mobilitygroup: 6MWT trend to walk further $P = 0{\cdot}01$. TUG $P = 0{\cdot}02$. The mean difference between the groups was 116 m (95% CI 31–201 m) in the 6MWT. Task related training effects were found
Salbach *et al.* (2004)	Community 1 year post stroke	$n = 91$	RCT Exp. $n = 44$	Exp: 10 functional tasks. Control: arm activities. 6 weeks/ 3×/week	6MWT, 5-meter speed, TUG, BBS	Between group difference was 35 m on the 6MWT (95% CI 7–64),TUG no difference
Salbach *et al.* (2005)	Community Up to 1 year after stroke	$n = 91$	RCT Exp. $n = 44$ Follow-up after 1 year (2004)	Exp: 10 functional tasks to strengthen lower extremities and walking balance. Control: armactivities 6 weeks/3×/week	6MWT, 5-meter comfortable walking speed, TUG. BBS, ABC	Walking intervention group; change in balance efficacy correlated with change in functional walking capacity R = 0·45, 95% CI = 0·16–0·68 (2005)
Nilsson *et al.* (2001)	Rehabilitation Center sub-acute phase < 8 weeks poststroke	$n = 73$	RCT Exp. $n = 36$ Follow-up 10 months	Exp: treadmill with Body Weight Support (BWS) 5 days /week/ 30 minute. 3–19 weeks. Control: walking training on the ground, no treadmill	FIM, FAC, Fugl Meyer, BBS	No statistically difference between the groups at discharge and in follow-up. Both groups improved on the tests. Walking on the ground and BWSTT are comparable choices early after stroke
Richards *et al.* (2004)	Rehabilitation Unit sub-acute phase	$n = 63$	RCT Exp. $n = 32$	Exp: training with a treadmill Control: no technology 1 hour/day/ 5 days/week/2 months	Gaitspeed, Fugl Meyer, BBS, TUG, BI (gait) Laboratory. measures: gait kinematics	All measures improved ($P < 0{\cdot}01$–$0{\cdot}05$). No differences between groups ($P > 0{\cdot}05$). The efficacy of task oriented training depends not on rehabilitation technology

Table 2 (*Continued*)

References	Setting/phase	Sample	Study design	Intervention	Outcome/measures	Results and conclusion
Peurala *et al.* (2005)	Rehabilitation center >6 months post stroke	n = 45	RCT 3 groups Follow-up 6 months	1. Gait trainer plus Functional Electric Stimulation (FES) 2. Gait trainer without FES 3. walking overground	10MWT, 6MWT., strength and spasticity LE, postural sway, Modified MAS, FIM	Scores in all tests improved (P < 0.001). However no differences were found between the groups. Performance remained improved after 6 months
Physical condition						
Duncan *et al.* (1998)	Discharged at home 30–90 days after stroke	n = 20	RCT Exp. n = 10	Exp: a home based exercise programme, therapist supervised, designed to improve strength, balance and endurance 8 weeks/3×/week	Fugl Meyer upper (UE) and lower extremity. (LE). Gait velocity, 6 m walking, BBS, BI	FM UE change 8·4 vs. 2·2, FM LE 4·7 vs. −0·9. gait speed 0·25 vs. 0·9 m/s. 6 m walking 195 feet vs. 114 ft. BI trend in difference. The difference in gait speed was statistically significant in change score 0·05 < 0·1
Duncan *et al.* (2003)	Community Stroke within 30–150 days	n = 100	RCT Exp. n = 50	Exp: exercise programme to improve strength, balance and endurance. Therapist supervised. Control: usual care 12–14 weeks/ 36×/30–90 minutes.	Strength, Fugl Meyer LE, BBS, endurance, Wolf Motor Function test UE, 10 m walk and 6 minute walk distance	Multivariate analysis of variance (MANOVA) testing the overall effect, the intervention produced greater gains (Wilk's λ = 0·64, P = 0·0056)
Katz-Leurer *et al.* (2003)	Rehabilitation unit sub-acute phase	n = 92	RCT Exp. n = 46	8 weeks cyclo ergometer training. 2 weeks/5×/week/ 10–20 minute, 6 weeks/ 3×/week/30 minute. Intensity: 60% of heart rate reserve	Aerobic capacity. Functional tests in stair climbing, walking time and walking distance until fatigued	Improvement in all aerobic parameters. Heart rate at rest (P = 0·02), work load and time (P < 0·01) statistically significant. A trend to sign. in functional tests, stair climbing was statistically significant better (P < 0·01)
Pang *et al.* (2005)	Community > 1 year post stroke	n = 63	RCT Exp. n = 32	Exp: fitness/mobility exercises stepping, walking, sit to stand, strengthening and balance. 19 weeks/ 3×/week/1 hour	O_2 consumption, 6MWT, strength, BBS, bone density femur neck, activity scale	Peak volume oxygen and 6MWT statistically significant improvement (P = 0·03). No statistically significant improvement in bone density, balance, strength and activity
Yang *et al.* (2006)	Community chronic stroke ≥ 1 year post stroke	n = 44	RCT Exp. n = 24	Exp: task oriented strength training in a circuit: standing and reaching, sit to stand, stepping. 4 weeks/3×/ week/ 30 minute	Muscle strength, gait performance on a instrumented walkway, 6MWT, step test, TUG	All selected tests improved statistically significant (P < 0·001). With exception of the step test. Strength gain associated with gain in functional tests (P < 0·001)

Table 2 (*Continued*)

References	Setting/phase	Sample	Study design	Intervention	Outcome/measures	Results and conclusion
Armtraining						
Winstein *et al.* (2004)	Rehabilitation unit acute phase 2–35 days after stroke	$n = 64$	RCT 3 groups Follow-up 9 months	1. Standard care (SC) 2. Functional task practice (FT) 3. Strength training (ST) ST and FT 20 hours additional hours beyond standard care	Fugl Meyer Strength Functional test of the hemiparetic Upper Extremity	FT and ST groups greater increases in FM scores ($P = 0{\cdot}04$) and strength ($P = 0{\cdot}02$). Effect was primarily in less severe patients. After 9 months, the less severe FT group continued to make statistically significant gains
Pang *et al.* (2006a)	Community Chronic ≥ 1 year after stroke	$n = 63$	RCT $n = 31$ arm group $n = 32$ leg group	Group training 9–12 patients supervised by 3 therapists. Arm group and leg group. 19 weeks/3×/week	Wolf Motor Function test, Fugl Meyer arm, grip strength, Motor Activity Log (MAL)	Statistically significant group/time interaction (Wilks $\lambda = 0{\cdot}726$, $P = 0{\cdot}017$. WMTF and FM statistically significant higher in *post hoc* analysis. Patients with moderate arm impairment benefited more.
Higgins *et al.* (2005)	Community < 1 year poststroke	$n = 91$	RCT Exp. $n = 47$	Exp: practice of uni- and bilateral tasks. 6 weeks/3×/week/90 min, 15 minute/day home training. Control walking	Box and Block test Nine hole peg test, grip strength. TEMPA	Baseline BBT average of 26 blocks in both groups, = 40% of age related values. Postintervention: both groups 28 blocks. No meaningful change in other measures
Taub *et al.*. (2006b)	Community chronic mean = 4·5 year after stroke	$n = 41$	RCT Exp. $n = 21$	CIMT, 6 hours/day/10 days plus restraint 90% of waking hours. Control: physical fitness and relaxation	Wolf Motor Function test (WMFT) Motor Activity Log (MAL)	Patients show large (WMFT) to very large (MAL) improvement in functional use (MAL $P < 0{\cdot}0001$). Changes persisted over the 2 years tested
Wolf *et al.* (2006)	Community 3–9 months poststroke	$n = 222$	RCT Exp. CIT $n = 106$	CIMT: repetetive training restraint 90% of waking hours. Control: no intervention	Wolf Motor Function test (WMFT), MAL	Between group difference WMFT 34% (95% CI 12%–51%, $P < 0{\cdot}001$) and the MAL between group difference 43% $P < 0{\cdot}001$
Wu *et al.* (2007)	Rehabilitation setting 0·5–31 months poststroke	$n = 26$	RCT Exp. $n = 13$	Exp. mCIMT, restraint 6 hours a day, 2 hours/5times/week/3 weeks Control: traditional therapy	FIM, MAL Stroke Impact Scale (SIS), HRQOL (quality of life)	Statistically significant improvement in motor function, daily function and the physical domain of HRQOL. FIM $P = 0{\cdot}018$, MAL amount of use arm $P = 0{\cdot}003$
Mental practice						
Page *et al.* (2007b)	Community chronic > 12 months poststroke	$n = 32$	RCT MP $n = 16$	Relaxation plus Mental practice (R + MP) Control: R plus physical practice 30 minutes/2 days/week/6 weeks	Action Research Armtest (ARA) Fugl Meyer UE	MP group had statistically significant reductions in arm impairment and statistically significant increase in daily arm function (both $P < 0{\cdot}0001$)

RCT, randomized controlled trial; CI, confidence interval; BBS, berg balance scale; TUG, timed up and go-test; ABC, activities specific balance confidence scale; NHP, Nottingham Health Profile; FM, Fugl-Meyer assessment; PASS, Postural Assessment Scale For Stroke Patients; CoP center of pressure, MAS, Motor Assessment Scale; RM, Rivermead Motor assessment; TEMPA, upper extremity test for older people; 6/10, 6/10 minutes walking test; FIM, Functional Independence Measure; BI, Barthel Index; MAL, Motor Activity Log; ARA, action research arm test; MP, mental practice; Exp, experimental group; CIMT, constraint-induced (movement) therapy.

Sit to stand

One study (randomization not blinded) focused on patients standing up from a chair. Repetitive sit to stand exercises plus symmetrical standing training resulted in statistically significant improvement in sit to stand performance and a decrease in the number of falls ($P < 0{\cdot}05$) (Cheng *et al.* 2001).

Walking

Seven studies that focused on walking of patients were included. In four of these, the intervention was task-oriented walking training with outcome measures of balance, gait speed and ADL. One study of good quality showed strong evidence for improved functional mobility after gait-oriented agility training in a circuit, even during the early stages after the stroke (Blennerhassett & Dite 2004). Two studies of good quality were performed in the community (Salbach *et al.* 2004) and follow-up in 2005 of the same population was reported (Salbach *et al.* 2005). Task-oriented walking enhanced self-efficacy in walking by statistically significant amounts. One study (Dean *et al.* 2000) with a small sample ($n = 12$) showed statistically significant improvement ($P < 0{\cdot}05$) in the strength of the affected leg during sit to stand after circuit training in which one of the workstations consisted of sit to stand exercises from various chair heights. Moreover, participants' walking speed increased. Three studies of high quality compared the effects of patients walking on the ground with patients walking on a treadmill (Nilsson *et al.* 2001, Richards *et al.* 2004, Peurala *et al.* 2005). In all these studies, which were performed in both the sub-acute and chronic phases, scores on walking tests improved but no differences were found between the two groups.

Physical condition and muscle strength

Three systematic reviews were found that focused on the improvement of physical condition among stroke survivors. One review, including nine RCTs, showed that aerobic exercise had statistically significant favourable effects on walking velocity and walking endurance (Pang *et al.* 2006a). The other two systematic reviews drew the same conclusion: functional programmes on cardio-respiratory fitness improved walking performance (Saunders *et al.* 2004, Van de Port *et al.* 2007). Five studies used interventions relevant to nursing practice. One showed that training on a cycle-ergometer in the sub-acute phase after stroke resulted in a trend toward functional improvement, and stair-climbing improved statistically significantly (Katz-Leurer *et al.* 2003). The other four studies, performed in the community, used an exercise programme focusing on strength, balance and endurance. There was good evidence that exercising benefits fitness and walking capacity (Duncan *et al.* 1998, 2003, Pang *et al.* 2005). Task-oriented progressive resistance training in a circuit with sit to stand, turning and stepping exercises could improve lower limb muscle strength and functional performance (Yang *et al.* 2006).

Two systematic reviews of muscle strength training in stroke survivors concluded that such training has uncertain effectiveness on functional performance, except for sit to stand and step-up exercises (Ada *et al.* 2006, Bohannon 2007).

Arm-training

In a systematic review, van der Lee *et al.* (2001) found insufficient evidence for the effectiveness of exercise therapy on arm function (van der Lee *et al.* 2001). In less severe paretic patients, arm function improved more after functional training than after strength training and usual care (Winstein *et al.* 2004). A functional training programme aimed at improving arm participation proved ineffective: the control group, who received a walking programme combined with ADL tasks such as carrying groceries, performed even better on arm tests. Improvement was only observed in patients who entered the study with better arm performance (Higgins *et al.* 2005).

Constraint induced movement therapy

In a systematic review including nine small RCTs, CIMT had a positive effect on improving arm function, but it is impossible to draw definitive conclusions because of the methodological variety of the studies (Bonaiuti *et al.* 2007). Recently, two studies of good quality were published. The Extremity Constraint Induced Therapy Evaluation (EXCITE) trial was a prospective, single blind RCT ($n = 222$) conducted at seven centres. CIMT showed statistically significant relevant clinical improvement of arm function in patients who had had a stroke within the previous 3–9 months (Wolf *et al.* 2006). Patients in the mild to moderate chronic phase receiving intensive training following the CIMT protocol, with a restraint on the non-affected arm for 90% of waking hours, showed a statistically significant improvement in the functional use of their arms compared with the control group (Taub *et al.* 2006a). A placebo controlled trial ($n = 41$) also showed positive effects of mCIMT on arm function (Wu *et al.* 2007).

Mental practice or mental imagery

The preliminary results of case studies on the effect of mental practice are positive. Recently, the first RCT of high quality

(n = 32) was published. The results show statistically significant reductions in arm impairment and an increase of arm function in daily activities in the mental practice group members ($P < 0{\cdot}0001$) (Page *et al.* 2007b).

Discussion

This review shows important evidence in favour of task-oriented training in daily nursing care. Balance training is more effective when it is related to a task (Bayouk *et al.* 2006). Sit to stand exercises result in improved standing-up and may reduce falls (Cheng *et al.* 2001). Walking on the ground has the same effect as walking with technical assistance such as treadmill training (Peurala *et al.* 2005). Arm training integrated into tasks has been shown to be effective (Higgins & Green 2005).

There were several limitations to this review. First, since no studies specifically addressing task-related training and nursing were identified, the findings need to be extrapolated to the nursing situation. This may seem arbitrary. However, in view of the strict method and criteria used, the findings are considered to be valid for nursing practice. Second, as we identified many interventions with very different study designs and outcome measures, it was impossible to conduct a meta-analysis of pooled results, and so the findings were described qualitatively. Third, we did not include papers in languages other than English, which may limit the generalizability of the findings.

In this systematic review, we found various interventions that proved to have important effects on patient outcomes. Generally, exercise tasks need to be specific, and should be practised as meaningful tasks (Van Peppen *et al.* 2004, Van de Port *et al.* 2007). There is a positive connection between improvement of physical fitness and functional performance. Fitness training should be an important component of stroke rehabilitation, as endurance after stroke is often compromised to a level that limits basic functioning in daily life (Pang *et al.* 2006a). The reduction in falls after agility training is an encouraging finding (Marigold *et al.* 2005) but larger studies are necessary. The American Heart Association recommended that rehabilitation training for stroke survivors should include circuit training and balance activities, and emphasised that nurses need to stimulate and provide opportunities to practise (Gordon *et al.* 2004). Scrutiny of the content of the exercises used in circuit training revealed that many are task-related, such as standing up from a chair (Pang *et al.* 2006a). As strength training is beneficial in improving functional outcome, it is remarkable that it is not always incorporated into rehabilitation programmes after stroke (Teasell *et al.* 2006).

It is uncertain whether enhanced therapy improves upper-arm function in patients with little voluntary arm movement (Teasell *et al.* 2006). Training the arm and lower extremity simultaneously with integrated meaningful tasks (meal preparation and housework) seems to improve specific functional activities (Higgins *et al.* 2005). When investigating the importance of a meaningful task, use of a favourite drink in an arm-reaching exercise elicited better performance (Wu *et al.* 2001). The outcomes of a study using modified CIMT with patients with minimal arm function are promising (Page & Levine 2007a). Nurses can play an important role in supporting and guiding patients during this demanding therapy.

Mental practice is a relatively new intervention. The therapy is based on the learned non-use phenomenon found in animal research in 1977 (Taub *et al.* 2006b). The first published placebo-controlled study of mental practice corroborates the efficacy of exercise programmes incorporating mental practice (Page *et al.* 2007b), and it should be seen as a promising technique for motor rehabilitation (Mulder 2007). Mental practice certainly offers possibilities for nurses since the movements can be imagined in any context relevant to the patient. Also, observation of an action performed by another person, combined with active execution of the same action, was tested with stroke survivors. With the additional component of observation, the impact of the intervention was statistically significantly greater than physical training alone. The authors suggest that application of this observational component of daily activities could enhance therapeutic effects (Ertelt *et al.* 2007).

Only 11 of the 33 RCTs included were performed in the (sub)-acute phase, but interventions such as sit to stand exercises, effective in the chronic phase, are feasible in the sub-acute phase as well.

Translation to daily nursing practice

Various authors have explored the roles of nurses in rehabilitation. Long *et al.* 2002) identified six roles: assessment, co-ordination and communication (also involving family members), therapy integration, emotional support and technical and physical care. Nolan and Nolan (1998)added the important contribution of being present throughout the day. Several researchers have explored the use of time with stroke survivors during the day. Bernhardt *et al.* (2004, 2007) showed that during the first 14 days after stroke the real time spent in rehabilitation activities to improve mobility and prevent further complications was only 13% of the active part of the day (between 8 AM and 5 PM), and more than 50% of the time patients were resting and waiting in bed. Overall, they were inactive and alone more than 60%

of the time (Bernhardt *et al.* 2004, 2007). Similar results were found in a study comparing therapy time in four centres in Europe: therapy time ranged from 10% in the UK to 27% in Switzerland. Nursing care ranged from 35% of the total therapy time in the UK to 5% in Germany (De Wit *et al.* 2005). The follow-up study showed that, as a consequence, personal care was better in the UK but functional recovery was better in the other centres (De Wit *et al.* 2007). Nursing time could be used more efficiently if nurses integrated functional tasks into daily care. The effectiveness of group training is an important finding for nurses (Dean *et al.* 2000, Marigold *et al.* 2005, Pang *et al.* 2006b). Patients may be encouraged to practise simple ADL together under the supervision of nurses and other professionals. Assisting patients with mobility and ADL are nursing interventions that need to be further developed, and the effects on the nursing situation need to be studied. Nurses can implicitly guide balance exercises during standing up and sitting down, for example while helping with dressing. They may train patients in reaching by putting objects further away than arm length, which may improve balance. Further, they may assist patients to exercise from sitting to standing from chairs of different heights. Patients may also be encouraged to practise outside the therapeutic session with dressing, laying the table and eating together.

A well-coordinated multidisciplinary team of professionals is important in rehabilitation after stroke. While each discipline has its own paradigm, most paradigms overlap to some extent. Therefore, multidisciplinary collaboration among healthcare professionals is important. This is because many interventions are undertaken to a greater or lesser extent by different team members (Wade 2005). Various studies have shown positive effects of nurse-led training, including a range of motion exercise programme (Tseng *et al.* 2007). Therefore, optimal multidisciplinary collaboration is of the utmost importance. If the patient is discharged to home, it is especially recommended that participation in a fitness programme be stimulated (Duncan *et al.* 2005,

Table 3 Practical recommendations for daily nursing practice

	Nurses may use the following activities	Positively influence
Balance exercises	Assist patients with implicitly balance exercise during sit-to-stand, dressing	Improves balance, self efficacy
Sit and reach	Putting objects further away than arm length so that patients need to reach for an object	Sitting balance
Sit to stand	Exercise sit-to-stand a few times a day, from chairs with different heights	Sit to stand, balance. May decrease number of falls
Walking	Walk patients with or without help (in a safe situation) from patients own room to other places in the unit/ward This may be done a few times a day	May improve walking ability, walking speed and endurance
Physical fitness	Encourage the patient to practise outside the therapeutic sessions. It would be very helpful to have some cycle ergometers in the ward.	Cycling improves functional status and physical condition
Physical fitness	Promote physical fitness classes and social walking for people living at home	Improves walking speed and endurance
Arm training	Activate the paretic arm and hand. Exercise repetitive functional, meaningful tasks that are chosen by the patient For example: self-care tasks, reading a book, eating	Improves arm function especially in patients with some arm and hand function. Improves self-care
Constraint induced movement therapy	Encourage (chronic) patients with some hand function to take part in a CIMT group. Nurses can performe a part of the treatment	Improves arm and hand function
Mental practice and action observation	Gain more in-depth knowledge about mental practice and start with a few tasks following the protocol stated in the literature Encourage observation of actions performed by others	May improve functional outcome
Agility training	Organize opportunities for step training (10 cm high)	May improve balance
Activities of daily living	Practise dressing a few times a day with the same jacket or T-shirt Observe at which point of the dressing process the patient has difficulties and focus practising the aspect the patient finds difficult	Improves self-care, Self-efficacy
Group training		May improve functional outcome
Self-efficacy training	Encourage the patient to do activities that he/she finds difficult to perform. Provide positive feedback and praise every improvement how minor it will be	May improve functional outcome
Activities already done in a ward	Create activities such as lay the table, eating together, care for flowers, distributing postcards	More, intensive therapy improves rehabilitation outcome

What is already known about this topic

- Task-oriented training is effective for stroke survivors.
- There is a shift from training at impairment level to training on activity level.
- Healthcare professionals spend little time providing therapeutic activities and treatment to stroke survivors.

What this paper adds

- Training needs to be repetitive, task-specific and meaningful for the individual.
- Many interventions in task-oriented training that have proved to be effective are usable in daily nursing practice, such as walking on the ground, moving from sitting to standing from different chairs, and sitting and reaching.
- Active use of task-oriented training in the daily nursing care of stroke survivors, will lead to improvements in functional outcomes and overall health-related quality of life.

Implications for practice and/or policy

- Nurses should collaborate with other professionals to create opportunities for patients to practise outside of regular therapy sessions.
- The effects of task-oriented training programmes provided by nurses in collaboration with other healthcare professionals need to be measured.

Langhammer *et al.* 2007). Nurses can emphasise the importance of practising functional skills and can endorse participation in physical exercise programmes.

There are no standardised functional tasks, and so nurses are challenged to construct meaningful tasks. The challenge is to increase the therapeutic input of nurses and other professionals in a time of staff shortages and cost restriction (Walker 2007). Possible interventions are summarised in Table 3. Commitment of the leaders is essential if changes in nursing practice are to be accomplished and support is particularly needed in relation to time, education and therapeutic space in a department. After making an inventory, it is sensible to start with a few interventions. The present review has highlighted many factors to consider in future investigations measuring the effects of task-oriented interventions within nursing practice.

The question is not if, but how nurses can incorporate task-oriented training into daily care.

Rehabilitation therapy can and should be integrated into the daily nursing care of stroke survivors.

Conclusion

Generally, task-oriented rehabilitation after stroke has proved to be effective and relevant for nursing practice. Improvement of impairments has long been seen as a prerequisite for functional movement, but interventions to achieve such improvement do not intrinsically carry over to functional improvement as the correlation between functional and laboratory measures is generally weak. A wide range of interventions, such as functional balance training during reaching and standing up, walking training, arm training and exercises for physical fitness need to be further developed and tailored to the patient's needs, in close collaboration with other professionals. CIMT and mental practice are relatively new and promising treatment approaches that are appropriate in nursing practice, and they need to be further developed and explored. Moreover, nurses can play an important role in creating opportunities to practise meaningful functional tasks outside the regular therapy sessions. Indeed, the effects of such task-oriented training programmes provided by nurses in collaboration with other healthcare professionals need to be measured.

However, current evidence suggests that by actively using task-oriented training in the daily nursing care of stroke survivors, functional outcomes and overall health-related quality of life will be improved for these people.

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Author contributions

MR, MS, EL & TBH were responsible for the study conception and design. MR & TBH performed the data collection. MR & TBH performed the data analysis. MR, MS, EL & TBH were responsible for the drafting of the manuscript. MR, MS, EL & TBH made critical revisions to the paper for important intellectual content. MS, EL & TBH supervised the study.

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