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Expanding Rehabilitation Beyond the Clinic—Strategies to Increase Total Restorative Therapy Time for Adults with Hemiplegia

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Abstract

Background: Positive neuroplastic changes involving cortical reorganization after stroke are experience dependent and are facilitated more effectively when rehabilitation occurs with high volume. Structured experiences to promote adaptive changes can be implemented during scheduled therapies in any rehabilitation setting. However, time spent in supervised restorative therapy is limited regardless of setting. Time spent in therapeutic activity can be extended by a variety of options that patients can engage in independently, that are low-cost, and that have evidence to support their use as a supplement to physical and occupational therapy. Purpose: The purpose of this paper is to present four such options for supplemental therapeutic activities to support restorative rehabilitation, including mental practice, mirror therapy, low cost virtual reality, and community group exercise classes. A sample of the evidence supporting their feasibility and effectiveness is presented. Practical guidelines for implementation are provided based on the evidence. Recommendations: Evidence based interventions can be used to extend total restorative rehabilitation time as an extension of therapy activities performed in the clinic. They are feasible and effective and can support positive neuroplastic changes in individuals with hemiplegia. These strategies can and should be implemented across practice settings by physical therapists, occupational therapists, and speech language pathologists.

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ABSTRACT

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Keywords: hemiplegia, mental practice, mirror therapy, virtual reality, community group exercise class, physical therapy, occupational therapy

INTRODUCTION

Neuro-rehabilitation post stroke is most effective when it is applied with high intensity and high volume to facilitate positive neuroplastic changes.[1] While intensity is a function of how hard the patient works, volume is a function of total time spent in restorative activity. The most appropriate dose of rehabilitation at the most appropriate time post stroke has not yet been resolved, but it has been reported that moderate improvement in outcomes is possible with more rehabilitation.[2] However, for those receiving rehabilitation post stroke, it has been reported that the volume of therapy provided may be insufficient to stimulate the cortical re-organization necessary to restore function.[3] Acute inpatient rehabilitation is the setting where patients receive the highest volume and the most intensive therapy services. Even there, the average length of stay has been reported to be only 8.9, 13.9, and 22.2 days for mild, moderate, and severe stroke respectively.[4] Additionally, while in an inpatient rehabilitation setting, the daily duration of combined physical, occupational, and speech therapies can be limited, meaning that negative neuroplastic changes may be facilitated through maladaptive movement patterns or inactivity. Given the average lengths of stay in inpatient rehabilitation, it also seems that the most intensive rehabilitation efforts are concentrated during the period of spontaneous biologic recovery, which occurs in the initial days and weeks after the stroke event.[5] It is possible for patients to have completed their inpatient rehabilitation, and to have transitioned to outpatient or home health services where the volume of therapy is markedly reduced, just as neuroplasticity becomes the mechanism for recovery of function. It is incumbent upon all therapists to encourage patients to engage in restorative activity outside of the time spent in the clinic and to continue a level of intensity and volume to support neuroplasticity when formal rehabilitation has ceased.

Restorative approaches to stroke rehabilitation largely occur during the time spent with rehabilitation therapists, but that time is finite regardless of the setting in which the patient receives therapy. Additional restorative efforts performed by the patient with high levels of repetition could increase the total volume of rehabilitation activity and promote optimal functional recovery. Several low-cost strategies have been identified, studied, and found to be effective. The purpose of this paper is to present four low-cost and readily available interventions that individuals with hemiplegia could engage in at home or in their community, each of which has the potential to expand total rehabilitation time without additional burden on clinicians or healthcare resources. We propose their use to supplement, not replace or reduce therapist interventions. We will present evidence that investigates their effectiveness and/or feasibility, and where possible, outline appropriate guidelines for their application. The strategies are mental practice, mirror therapy, low-cost virtual reality, and community exercise programs. All of these strategies could be implemented to supplement the rehabilitation efforts of physical, occupational and speech language pathologists. In addition, two of these approaches could engage the families and friends of those recovering from stroke as an extension of the rehabilitation team.

MENTAL PRACTICE

Mental imagery has been described as the ability to create mental correlates of movements or tasks without an external stimulus.[6] The term motor imagery is often preferred by researchers when the mental imagining involves human movement.[6] Mental practice (MP) implies a training procedure with extensive repetition of imagined movements or tasks with the intention of improving performance.[6] This mental imagining of the performance of a motor act occurs in the absence of any physical actions.[7] The definitions of the types of mental imagery do not appear to be universal, but broadly speaking, internal imagery involves the experience of being inside one's own body - a first person perspective. External imagery involves more of an observer's experience, as if watching oneself from a distance or on video. Kinesthetic imagery implies some sensation is elicited by the action imagined.[6] The distinction between visual and kinesthetic imagery has been described as "highly artificial," and the application of both seems feasible and appropriate for most individuals.[8,9] There is a substantial body of evidence supporting the use of MP for rehabilitation post stroke. When employing MP, improvements have been noted in learning for both familiar and novel tasks by individuals with acute stroke. Carryover and the ability to generalize the skills and tasks have been reported.[10] A 2016 systematic review supported the use of MP as an adjunct to physical therapy (PT) in the rehabilitation of extremities, activities of daily living (ADLs), and motor skills. While supporting the use of MP, authors propose that additional research establishing specific effective MP protocols is necessary.[11]

The most abundant evidence for application of MP post stroke is in the area of UE rehabilitation. A recent meta-analysis of randomized controlled trials (RCT) investigating MP for upper extremity (UE) rehabilitation reported that it is effective and recommended its use to improve outcomes.[12] The majority of studies support use of MP as an adjunct to physical practice.[13,14] The benefit of adding MP to modified constraint induced movement therapy (mCIMT) has been studied and found to be significantly more effective than mCIMT alone in the areas of corticospinal excitability, UE function, and the performance of ADLs.[15]

The investigations into the use of MP to improve lower extremity (LE) movement, performance of ADLs, and gait post stroke are currently very limited but growing in number. A 2015 update of Canadian stroke rehabilitation practice guidelines recognized the value of MP indicating that it could be considered for use as an adjunct to LE motor retraining.[16] When MP was added to physical practice, improvement in performance of a sit to stand transition was demonstrated.[17] While the majority of studies examined clinic

based application of MP, home-based MP has been used successfully for gait retraining, showing significant improvements specifically in walking speed, stride length, cadence and single leg support time on the affected LE.[18] During MP of gait, it has also been recommended that the patient should focus on a specific aspect of the gait cycle e.g. knee control.[18]

Mental practice procedures are not well defined or described. A synthesis of MP protocols was provided in a systematic review of studies investigating MP effectiveness and feasibility.[11] Authors described the combination of mental and physical practice as the predominant application, initiating the MP session with a relaxation activity, followed by mental rehearsal of the chosen task. MP was commonly facilitated by video or audio guidance, and sessions lasted for a mean time of 30 minutes.[11] It is also generally recommended that the person imagine perfect performance of the task or movement within a poly-sensory experience. All MP interventions should be planned and goal driven, and supervision and guidance is recommended.[9]

Dickstein described a gait regimen of MP that involved 15 minutes of imagined gait, performed 3 times a week for 6 weeks, using modules that progressed from addressing specific gait impairments, to integrating aspects of gait function designed to increase speed and efficiency and ultimately to walking practice.[19] Liu described a successful experimental regimen addressing ADLs that involved 3 practice sets of 5 ADL tasks, practiced for 1 hour, 5 hours per week for 3 weeks, and the tasks got progressively more challenging throughout the duration of the study.[10] An alternate regimen for ADL retraining involved performance of UE ADL activities for 30 minutes, twice a week for 6 weeks, and included relaxation and refocusing time. A specific protocol provided by Dunsky and Dickstein in 2018 described the phases of their experimental MP regimen: muscle relaxation, description of the task and the environment that is to be imagined, use of both visual and kinesthetic imagery, and re-focusing to the real word environment. The regimen involved 15-20 minutes of practice, 3 times per week for 6 weeks, and included problem solving challenges and positive reinforcement.[20] To improve performance of the sit to stand transition, approximately 1,100 MP repetitions combined with 120 physical practice repetitions produced significant gains and retention of those gains over time. Training was provided three times per week for four weeks individually in a quiet room. Each physical repetition of the rise to stand task was separated by a series of mental repetitions of the same task.[17] In the literature relating to stroke rehabilitation, the emphasis has been on dedicated MP sessions, with a training schedule similar to physical practice. A shorter version of imagery, lasting only seconds, can be used immediately prior to execution of a motor task e.g. prior to transferring to or from the toilet or chair.[21]

Despite the evidence supporting the benefits of MP, it has proven challenging to integrate MP into regular rehabilitation programs.[22] Regardless of setting, MP would require instruction by the therapist to ensure effective application when the patient was engaging in MP outside of structured therapy. The therapist would select the appropriate activity for the patient to focus on during MP, and would provide a prescription for implementation. The activities selected would match and reinforce those that are practiced during therapy sessions. These strategies can be applied in any setting: inpatient rehab, subacute rehab, home health, outpatient clinics and following discharge from structured therapy, but it is possible that the time needed to ensure adequate training to achieve effective MP is a deterrent to its use. In order to extend the total rehabilitation time, MP could be introduced during scheduled therapy, transitioned to an independent program as an adjunct to rehabilitation therapies, and prescribed with performance parameters similar to physical practice. Currently, MP is facilitated by video or audio guidance, but it has been suggested that adherence to a MP program could be facilitated by use of dynamic interactive applications on smart devices.[22] The short version would be ideal to prescribe for implementation immediately prior to a frequently performed transition like sit to stand to enhance performance of each trial throughout the day, every day. Both the long and short applications of MP could greatly increase the stroke survivor's engagement in restorative activity, increase the daily number of repetitions of meaningful tasks and thus support positive neuroplastic changes. In summary, mental practice should not be underestimated when considering stroke rehabilitation.[15]

MIRROR THERAPY

Mirror therapy (MT) is a low-cost intervention option that can be performed independently for the remediation of impairments and restoration of movement post stroke. Mirror therapy is applied using a mirror box in which the affected extremity is kept hidden inside the box while movement of the sound extremity is reflected in a mirror. This creates the illusion of normal movement in a hemiparetic extremity. The mirror image of the sound extremity provides a visual stimulus, which is interpreted by the viewer as normal movement in the affected extremity. That, in turn, can promote positive neuroplastic changes, increase movement, and improve motor activity. Functional magnetic resonance imaging (fMRI) has been used to explore how MT works in individuals post stroke by examining neural network activity occurring during LE MT activity. The finding of increased ipsilateral sensorimotor activity indicates that MT may facilitate cortical re-organization allowing improved motor activity in an affected LE.[23] In this way; MT can enhance positive neuroplastic changes as the brain is made to think that the affected extremity is moving and therefore needs cortical support to enable that movement. With repetitive reminders of how to move the affected extremity, connections are reinforced and the ability to effectively complete a motion is promoted.

The body of evidence supporting the use of mirror therapy during stroke recovery is growing, and benefits have been reported at every phase of recovery. Several recent systematic reviews have supported the use of MT as a rehabilitation tool used in isolation or as an adjunct to conventional rehabilitation. In 2018, a systematic review with meta-analysis identified several benefits of MT.[24] Investigators included 37 randomized controlled trials (RCTs) with a pooled sample of 1,685 participants. Meta-analysis revealed that MT could improve motor function and ADLs and reduce pain perception. In addition, authors identified that 4 weeks of MT applied as an adjunct to conventional rehabilitation, with or without concurrent use of electrical stimulation, might be the most appropriate application of MT for addressing motor and ADL deficits.[24] An updated Cochrane review included RCTs published up until August, 2017 with a total of 62 studies and 1,982 participants.[25] Studies examining adult participants with paresis of the upper or lower extremity, or both, caused by all types of strokes, all severities of stroke and at all stages of stroke recovery were included. In the majority of these studies, participants received either MT or a control therapy. Mirror therapy programs varied in application from 3-7 times per week, from 15-60 minutes per session, with a duration of 2-8 weeks. Investigators reported moderate quality evidence that supported use of MT to improve UE and LE motor function, remediate motor impairment, and improve ADL function. They reported low-quality evidence to support the application of MT to reduce pain and remediate unilateral neglect. The authors concluded that MT could be used effectively, at least as an adjunct to conventional therapies, for individuals at any stage of rehabilitation.[25] As a counter to this finding, an RCT with blinded assessors investigated the impact of MT on UE recovery within the first 4 weeks post stroke in an acute inpatient rehabilitation setting. When MT combined with conventional rehabilitation was compared to sham therapy combined with conventional rehabilitation, there was no added benefit found with MT.[26] These results indicate that MT might not be optimally applied during the acute phase of recovery, but do not conflict with findings regarding MT at later stages of recovery.

Investigation into MT to improve LE function is much rarer than UE, but one systematic review looked specifically at the impact of MT on LE rehabilitation.[27] Only five studies were included in the review, 1 case study and 4 RCTs with a total of 135 participants, a variable duration since stroke onset, and an age range of 28-86. The application of MT varied considerably from 1- 4 times per day, 5-7 days per week, and 2-4 weeks' duration. In addition, there was no consistency in the protocols used for the MT intervention. Authors concluded that MT may be beneficial in the rehabilitation of LE function, but that there is not enough evidence to draw definitive conclusions about its efficacy, particularly regarding its optimal use, and identification of specific applications at different stages of recovery.[27] In 2018, this position was supported by a systematic review with meta-analysis of the impact of MT on lower extremity recovery post stroke.[28] Despite significant positive outcomes in the areas of motor recovery, passive ankle range of motion, balance and gait velocity, authors cautioned against overly positive interpretation of results from studies with small sample sizes.[28]

In order to truly expand total restorative rehabilitation time, MT should be practiced independently to supplement therapies in the clinic as soon as training in the intervention has been successfully completed. Independent use of the mirror box has not been investigated to date, but a study has examined supervised MT in the home versus supervised MT in the clinic.[29] Investigators compared 2 groups each receiving 30-45 minutes of MT and 45-60 minutes of task specific training at each treatment session. The differences between the groups' experience were the environmental context, the specific objects incorporated into the MT activity, and modes of MT used. Additionally, the specific activities in the clinic were simulated rather than real-life and were less individualized. The groups of 12 were similar at baseline, and inclusion criteria allowed participation between 1 and 5 years post stroke. The home based and clinic-based MT groups experienced differential benefits. Participants in the home-based group experienced greater improvement in UE daily tasks and LE strength in sit to stand, while the clinic group experienced greater benefit in health status. Both groups improved similarly in outcomes related to impairments.[29] While this study supports the feasibility of MT as a home-based intervention, independent use by participants should be explored.

There are no standard protocols for the application of MT as an intervention post stroke and it has been posited that little is known about which patients are likely to benefit the most from MT, or the most beneficial prescription for MT.[30] A pilot study compared the impact of simple movement MT and task-oriented MT on the UE function of 4 participants who were more than 6 months post stroke. There were 15 intervention sessions for both strategies. For simple MT, 2 participants performed 5 different UE motions; 3 finger/thumb movements, 1 wrist motion and 1 elbow motion. For task-oriented MT, 2 participants were asked to perform a grasp and release motion, pinching tongs, using a spray bottle, kneading putty, using a spoon, lifting a heavy can, and wiping a table with a towel. Assessment using the Box and Block Test, Cube Carry Test, Card Turning Test and the UE portion of the Fugl-Meyer Assessment revealed that all 4 patients improved but that only those practicing task-oriented activities continued to improve after the termination of therapy.[31] While we do not have evidence-based protocols for MT, the systematic reviews indicate that outcomes can be positive with a variety of MT modes. From the reviews cited above, it can be seen that MT programs including therapeutic exercise, therapeutic activity, and task specific training can all be used to increase motor function in the extremities, improve ADLs, decrease pain, and potentially remediate unilateral neglect. Stroke Engine has provided some specific exercises and activities for the upper extremity that can be performed during MT.[32]

To achieve an increase in total restorative rehabilitation time, a mirror therapy program could be added to a plan of care following instruction by a physical or occupational therapist. This can be applied initially as an intervention in the clinic, transitioned to a home program while the patient is still receiving therapy, and can be continued post-discharge. Initial use of the mirror box could be overseen by the therapist while the patient is learning to use it effectively and then performed independently by the patient at home. Mirror boxes can be purchased inexpensively by the patient or made by the therapist or a family member at home using very inexpensive materials. Commercial versions have been constructed so that the person with hemiplegia can set them up independently and implement the program without assistance. While specific protocols have not been identified, the most common duration seems to be 4 weeks, and the most common frequency appears to be 5 days per week for a minimum of 30 minutes per day.[32] MT can be practiced by moving only the sound extremity while watching its reflection, moving both extremities while watching the reflection of the sound extremity, and can be performed with simultaneous electrical stimulation of the affected extremity. Simple movements can be prescribed, task specific training can be performed, and ADLs can be practiced using the mirror box. In summary, MT is an inexpensive, feasible adjunct to traditional interventions for hemiplegia that is supported by an emerging body of evidence.

VIRTUAL REALITY

Virtual Reality (VR) is an expanding area of rehabilitation for individuals with hemiplegia, and the advances in VR technology indicate that it is likely to increase and diversify.[3] Virtual reality offers the opportunity to engage in repetitive, intense, and task-oriented restorative activity in a simulated sensory-rich environment. It allows therapists to prescribe VR activities that support motor learning principles and neuroplastic processes. Virtual reality has been described as an interactive experience where simulations have been created using computer hardware and software that allow users to engage in environments that are similar to the real-world.[3] The virtual environment can involve a range of visual interfaces, each of which can provide different levels of immersion and interaction.[33] Fully immersive VR systems have been developed and are appropriate for clinic use, but many of these are expensive and require dedicated technology.[33] Low cost options include VR goggles with smartphone applications and gaming systems, many of which can be purchased second-hand for a significantly reduced cost. Participants interact using extremity movement and/or total body movements to engage in a variety of activities designed to restore movement and improve ADLs, balance, and gait.

It has been proposed that VR is an important part of the future of neuro-rehabilitation, that skills can be learned in VR, that there is transfer of skill to the real world, and that patient involvement is very important in making VR environments relevant.[34] Recent systematic reviews explore the effectiveness of VR in rehabilitation post stroke, but are not specific to low-cost VR systems. A Cochrane Review, updated in 2017, examined a wide range of VR programs employed across a variety of rehabilitation settings.[35] Key findings indicated that when VR was used to increase total therapy time, there was some improvement in UE function. Some evidence revealed a benefit to adding VR to improve ADLs, but advised that all conclusions should be viewed cautiously.[35] Several other systematic reviews have supported the use of VR as an adjunct to conventional therapy specifically in the areas of balance and gait function.[36–38]

Use of VR, specific to UE rehabilitation, has been largely supported in terms of feasibility and efficacy.[39-41] However, studies involving low-cost and readily available gaming systems have had mixed results. Saposnik et al provided support for the safety, feasibility, and effectiveness of VR gaming to facilitate rehabilitation therapy and promote UE motor recovery after stroke.[42] Researchers supplemented standard care with the Nintendo® Wii gaming system (VR Wii) requiring UE activity and found significant improvement in UE performance when compared to a group receiving standard care and recreational therapy.[42] Virtual reality has been used successfully to improve balance function in community dwelling stroke survivors. Balance games in the Nintendo® Wii Fit Plus and Xbox 360 Kinect were used to replace 30 minutes of a 120-minute group exercise class, twice a week for 12 sessions. Outcomes were similar for those engaging in VR and 90 minutes of group exercise and those completing the full 120-minute group exercise class, with both groups demonstrating improvement in functional mobility.[43] Standen et al provided low-cost VR equipment to investigate participants' use of VR in the home.[44] The system translated movements of the fingers and hand into game play. There was significant variability in adherence to the prescribed program of 3 times per day for up to 20 minutes per session for 8 weeks. Authors identified VR as a promising approach that allows flexibility and is potentially motivating as a means to increase opportunities for rehabilitation. However, they also propose that VR should not be viewed as an alternative to therapist-provided intervention but rather as supplement.[44] Currently, there is no research specifically investigating the use of low-cost VR goggles with smartphone applications that are specific to stroke-rehabilitation, but their low cost could make them very relevant as smartphone applications are developed.

Despite the growing body of evidence, application of VR across rehabilitation settings and integration into routine restorative efforts post stroke is not pervasive.[45] Specific prescriptions and protocols have not been readily available, which may relate to the variety of devices and technology that make up VR. While there are very few specific application protocols for VR, there have been multiple

reports of greater participant enthusiasm and enjoyment of the VR experience as a modality for rehabilitation.[33,39,44,46] This bodes well for the potential of VR to extend total therapy time, where use of a virtual environment may allow additional options for practice that might be unsafe in the real world.[34] VR might also contribute to greater adherence to an activity program, with games selected particularly for the purpose of remediation of movement. VR gaming is such a pervasive activity in society that it could also increase social engagement with family and friends and tap into the competitive spirit of gamers. It could effectively supplement therapist intervention, support UE rehabilitation, balance remediation, ADL activity, and gait training by increasing total rehabilitation time in any of these areas. Implementation of VR into rehabilitation would initially require therapist oversight in selecting the appropriate games or activities before transitioning to independent or supervised use at home. The therapist could also recommend the volume and intensity of the selected games or activities. VR can support the principles of neuroplasticity using high repetition, high intensity, meaningful and motivating activity and it can be prescribed to incorporate practice conditions that support motor re-learning. While evidence supporting low-cost readily available VR systems is limited, the overall outlook for the use of VR to extend total rehabilitation time is very positive, and patients should be encouraged to engage in VR gaming in addition to their regularly scheduled physical or occupational therapy activities.

COMMUNITY EXERCISE CLASSES

As far back as 1999, a professional perspective recommended that rehabilitation professionals should extend services into community fitness centers and facilitate good health practices for individuals with disability.[47] A similar recommendation was proposed when a supervised exercise training program for individuals post stroke with multiple comorbidities was shown to be effective in improving fitness, and potentially reducing the risk of further disease and disability.[48] Despite these early recommendations, education about community based exercise programs post stroke is not provided consistently to the majority of people and there is also a lack of suitable programs and efforts to implement them.[49]

Physical inactivity is highly prevalent after stroke, despite the fact that it is generally accepted that exercise training improves aerobic capacity, strength, functional capacity, ADLs and quality of life. In fact, a study conducted in 2015 concluded that people post stroke were inactive the majority of the time, particularly during the first year after onset.[50] It has been recommended that physical activity and exercise can and should be integrated into any stroke rehabilitation program to decrease the negative impact of a sedentary lifestyle and to reduce the risk of a second stroke.[51] A group exercise class designed to meet the fitness and activity needs of individuals with hemiplegia could be an ideal forum for expanding the time they are engaged in physical activity and could potentially be designed to address the movement impairments associated with stroke making it restorative in nature.

There is a significant body of work supporting the positive effects of group exercise classes after stroke. Circuit class therapy (CCT) can provide a supervised group activity to practice tasks, increasing practice time without increasing demands on therapists. A Cochrane review, updated in 2017, examined the efficacy and safety of CCT.[52] Trials presented in the review included those involving adults over 18, those with stroke of any severity or duration, and those seen in any practice setting. Seventeen trials were included in the review involving 1,297 subjects. The trials compared CCT to sham therapy or to conventional therapy. Findings indicated moderate evidence supporting use of CCT and indicated the following beneficial outcomes: improved velocity and increased distance ambulated, greater functional independence, and inconsistently, better balance function.[52] A small study of individuals with chronic stroke who participated in a short-term (8 weeks) community based exercise program supports the benefits of a class that focused on strength, conditioning, mobility, balance, and meaningful activities for those attending.[53] Rate of perceived exertion (RPE) was monitored and kept at 11-13 (on a 6-20 point scale) due to the presence of co-morbidities among participants. The client staff ratio was 3:1 for safety during more challenging activities. There was a significant improvement in the variables examined: balance, distance walked, gait speed, and stair speed, and the improvement was maintained at examination 1 month after completion of the class.[53] Similarly, a study looking specifically at cardiorespiratory fitness and walking capacity found that a community-based interval training program in addition to individualized home exercise program was both feasible and effective with improved conditioning and walking function.[54]

The Fitness and Mobility Exercise (FAME) group exercise program for stroke was developed to address impairments associated with mild to moderate chronic stroke. Participants attend 2-3 sessions per week for 2 to 6 months and each session includes warm-up whole body exercise, gentle stretching, strengthening through function, balance and agility exercises, and conditioning. The FAME program encourages socialization, education, fun, low music, and special events. Trials of FAME revealed improvements in multiple areas including pain, strength, walking endurance, ADLs, energy levels, mobility, and perceived quality of life, posture and balance.[55] When 2 community exercise classes for older adults post stroke were compared, the class emphasizing agility had better outcomes than the class emphasizing stretching and weight shifting in terms of postural reflexes, functional balance, and mobility with the potential to reduce falls.[56] This indicates that agility training can be implemented in community exercise classes to promote restoration of advanced mobility function. Participants in a group exercise class that focused specifically on UE and functional recovery demonstrated improvements that were comparable to those reported in studies involving constraint-induced

movement therapy or robotic assisted exercise.[57] From these studies, we can learn that successful classes have a number of common elements: strengthening through function or therapeutic exercise, balance and gait activities, functional activities in traditional or circuit format, and that there is evidentiary support for classes focusing on specific motor skills such as agility or UE recovery.

When establishing a community-based exercise class for individuals post stroke, there are several factors to be considered. Participants should be medically screened prior to attending class. Refer to suggested inclusion and exclusion criteria (Table1). Physical or occupational therapists, exercise physiologists, or trained instructors can collaborate with municipal recreation centers to provide an exercise class that is safe, feasible, and beneficial to participants.[58] An exercise class offered by a community organization can be safe and efficacious. It can lead to improvement in motor function and prevent decline in function over time.[59,60] Therapists or trained instructors could offer classes at a local gym, church hall, adult daycare center, and community activity center. Enough space is needed for each individual to reach both arms out, turn in full circles and walk without interfering with another participant (distance to be determined by class activity). Minimal specialized equipment is needed: a standard chair, floor mat, step, weights, elastic resistance bands/TheraBand, and heart rate monitors. Liability is an issue that would need the advice of an attorney and the validity of liability waivers would have to be investigated and legal advice taken. As an unskilled activity, no individual plan of care, no individual goals, no individual assessment would be needed, but a medical clearance form, medical history/medication list, attendance record, activity log, and any incident reports would need to be kept. There are a variety of options for the design of a community exercise class for stroke survivors. Some samples and suggestions are presented in Table 2. As a valuable service to stroke survivors, a community class can be marketed and advertised and could ultimately increase the profile of a participating clinic or therapist while making a positive impact on the lives of individuals. Evidence supports the feasibility and efficacy of community-based exercise classes for individuals post stroke, and the professional community has long recommended their implementation as an important element of the recovery process. Participation should not be limited to immediate recovery, but ideally could become a lifelong positive health habit that can help reduce the risk of additional stroke or adverse health events/conditions.

Table 1: Sample inclusion and exclusion criteria for participation in a community class post- stroke[61]

Sample Inclusion Criteria	Sample Exclusion Criteria
• The ability to walk short distances (e.g. 3 meters) with or without an assistive device (e.g. cane, walker, ankle brace) with minimal supervision/support. This is important if standing and/or walking activities are included in the exercise program. • The ability to perform standing exercises while holding on to a support. This is important if standing and/or walking activities are included in the exercise program. • The ability to follow instructions or mimic exercises (with or without support). • The ability to self-monitor and understand the concepts of “perceived exertion” and/or “target heart rate”. • The ability to communicate adverse effects such as pain or fatigue or the need for assistance.	• Failed medical clearance • Impulsivity requiring supervision to ensure the safety of the person with stroke and/or the other participants • Incontinence (unless appropriate undergarments are worn) • Open wound, contagious conditions • Behavioural issues that will negatively impact on others in a group setting

Table 2: Sample design ideas for group community class for individuals post stroke

Design A		Design B	Design C
Create a set of exercise activities based on impairments and disordered movement typically seen post stroke		Circuits: Station examples to be performed with or without a support chair or assistant	Walking group/program
a) Lack of symmetry	Almost all exercises addressing weakness could be done using functional transitions emphasizing symmetry e.g. sit to stand, squats, step-ups, step ups and reaching	1. Flexibility station on mat (hook-lying) 2. Sit to stand 3. Kneel walking 4. ½ keel to stand 5. NuStep 6. Rebounder 7. Step ups 8. Ladder 9. Foam activity 10. Stand and reach targets 11. Mini-trampoline 12. Walking	Standard protocol
b) Decreased weightshift and WB on affected side	Exercises in sitting, quadruped and kneeling that could facilitate that depending on level of the patient		
c) Reduced bimanual ability	Bimanual exercises		
d) Loss of speed and distance of gait	Relays, laps, tag		

DISCUSSION

While the evidence supports each of the 4 strategies outlined in this paper, the individual has to actually engage in the activity with volume and intensity that would support positive neuroplastic changes. The outcome will only be as effective as the effort put forth by the individual. Adherence to home exercise programs (HEP) such as those typically prescribed by therapists (a list of exercises) seems to be less than ideal. It was recently reported that only 69.3% of those who were provided with a HEP performed at least some elements of the program[62]. According to Jurkiewicz, "the most common factors preventing performance of home exercise programs post stroke were a lack of motivation, musculoskeletal issues, and fatigue." He also identified an inverse relationship between age and adherence.[63] The strategies for extending total restorative therapy time presented here have several features that could enhance ongoing engagement in activities that foster recovery. It has been proposed that virtual reality can mitigate some of the barriers to self-managed activity when applied to upper extremity rehabilitation.[64] VR gaming taps into the competitive spirit of the player which can be very motivating, as can the social engagement when interacting with other players. A study conducted in Australia examined predictive factors for participation in group physical activity class after stroke.[65] The authors concluded that better health status could be a predictor for average steps taken per day, but that predicting adherence in stroke survivors was difficult.[65] Community classes offer socialization, accountability, structure, and routine that could all potentially support attendance and engagement. Mental practice and mirror therapy are both activities that do not require support for set-up and can be done in any environment which allows easy integration into daily life. Mental practice does not require any equipment or financial investment. Because it does not involve any physical activity, it is ideal for those who have musculoskeletal issues, fatigue, or safety concerns. Mirror therapy provides the illusion of normal movement in the hemiplegic arm which could be motivating for some individuals. Understanding that adherence is an issue with self-managed activity and that barriers exist which contribute to poor adherence, it is suggested that every effort should be made to mitigate the barriers, to match the self-managed activity to the patient's interests, and to ensure that the demand of the activity is within the ability of the patient.

CONCLUSION

Neuroplastic changes depend on experience, and rehabilitation post-stroke is focused on providing experiences that promote adaptive cortical reorganization. However, time spent in structured therapy can be limited and of short duration regardless of setting. It is important for physical and occupational therapists to explore strategies that extend the volume and intensity of restorative activities beyond the time spent in clinic. The four strategies presented in this paper could be used by both physical and occupational therapists and have the potential to achieve the increase in volume that is essential for positive neuroplastic changes. There is a growing body of evidence supporting their feasibility and efficacy. They can be used to supplement rehabilitation activities

performed in the clinic as soon as the person demonstrates effective performance at a volume and intensity that promotes neuroplastic changes. Once training is completed, these strategies do not place any additional demand on healthcare resources. As with all rehabilitation endeavors, supplementary rehabilitation strategies should be used selectively and judiciously, and applied on an individual basis according to each person's needs and circumstances. While the strategies described in this narrative review can be used to supplement active therapy, they can also continue to be used after formal rehabilitation has been completed as a means to prevent decline in motor and mobility function, and in the case of the community classes, to promote health and wellness.

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