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Review article

Principles of rehabilitation for common chronic neurologic diseases in the elderly

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ABSTRACT

Rehabilitation plays a crucial role for elderly people with chronic neurologic diseases. The purpose of rehabilitation serves to restore capabilities and postpone dysfunction as the diseases progress. Comorbidities are common among older people, and, therefore, the rehabilitation approaches and outcomes for them may be different from the young population. In this article, we reviewed techniques for rehabilitation treatment of Parkinson disease, Alzheimer disease, stroke, and vestibular diseases. General rehabilitation principles for older people were also discussed to better understand the challenges we encounter during rehabilitative interventions of these diseases.

1. Introduction

Rehabilitation is important to the management of individuals with chronic neurologic diseases. Sedentary lifestyle, bedridden status, or muscular disuse secondary to neuromuscular disease may lead to many physiologic problems such as muscular atrophy, limited range of motion (ROM) of major joints, decrease of endurance, and finally, to a deconditioned status. By the age of 70 to 80 years, 20%–40% of muscle strength will be lost, and this may cause some disability.[1] Appropriate exercises can play a crucial role in improvement and prevention of degenerative disease,[2,3] maintenance of cognitive function,[4] decrease of depression, and improvement in quality of life. Some muscle strength can be regained (5%–40%) with training.[5] The advantages of exercise also include neuroplasticity and the ability of self repair of the brain.[6]

In the following text, we will introduce the rehabilitation strategies for stroke and three neurodegenerative diseases: Parkinson disease (PD), Alzheimer disease (AD), and vestibular disease. While there is crossover of need for rehabilitative therapies, stroke has more specifically defined needs of recovery of function, whereas in PD and much more so in AD the need is preservation of function and prevention complication or comorbidities.

2. Rehabilitation in PD

Problems commonly encountered by patients with PD are difficulties in initiating movements, pathologic tremor, rigidity, bradykinesia,[7] flexion posture, as well as abnormal gait patterns and impaired balance.[8] These symptoms all decrease mobility, and, subsequently, may lead to falls.[9] Some patients with PD also have speech problems. Studies revealed that patients with PD have lower functional abilities and strength in comparison with healthy individuals.[10–12] If exercise could be introduced in the early stages of the disease, physical degeneration could be ameliorated.[13,14] Keus and colleagues[15] recommended four areas of exercise for patients with PD, which included cueing strategies, cognitive movement strategies, balance improvement exercises, and joint mobility and muscle strengthening exercises. The purpose of rehabilitation intervention is to maximize functional ability and to slow down the progression of PD.[7]

For posture correction and muscle strengthening, rehabilitation programs include correction of faulty posture, balance training, and flexibility exercises. Poor posture in patients with PD may be related to a reduced gait velocity, which may lead to limitations of locomotion. To rectify posture, stretching tight extensor muscles and strengthening weak flexor muscles are most important. Trunk

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extension movements combined with breathing exercises should be emphasized. Exercises to improve ROM such as head extension, shoulder flexion, or trunk extension should be part of the exercise programs. For muscle strengthening, riding a bicycle ergometer or resistance exercise is beneficial for patients with PD. Dibble and others[16] reported that high intensity eccentric resistance training for patients with PD could increase muscle force, decrease bradykinesia, and improve the quality of life. The advantages of resistance training are enhanced muscle strength and functional capacity in the elderly[17] as well as in patients with PD.[18]

For gait and mobility, the combination of motor set deficits (hypokinesia) and altered motor cue production (sequence effects) may lead to festination and freezing of gait.[19] Freezing is also related to asymmetry of gait,[20] which is more severe during turning than walking straight. To overcome the difficulty in turning and freezing of gait,[9] patients with PD are asked to follow marks on the ground and increase step length while walking. Lim and colleagues[21] found that gait speed could be improved by auditory cues. Nieuwboer and others[22] used a prototype cueing device in a home physical therapy program and found that the severity of freezing was decreased, the speed of gait was increased, and balance was improved. Therefore, cueing training might be a beneficial intervention to improve the gait of patients with PD. However, particular attention should be paid to patients under levodopa therapy, as the "on-off phenomenon" will gradually become apparent as the disease progresses. Levodopa may benefit gait performance during the "on" phase, but deterioration would be prominent during the "off " phase. Tailored physical therapy, including gait and balance training, according to the timing of levodopa medication to ensure the patient is in the "on" state during training, and medication adjustment including increasing the frequency of dosing and shortening the interval between dosing at daytime is always paramount when developing the treatment plans for patients with PD.

Tremor is another symptom that patients with PD experience. Due to the observation that the tremor can be worsened during anxious period, behavioral intervention such as biofeedback and relaxation technique could be utilized to ameliorate the pathologic resting tremor in patients with PD. Treadmill training is another useful intervention. It can reduce the severity of disease and improve aerobic capacity of patients.[23] The rotating treadmill has become a new therapeutic tool to improve freezing symptoms during turning.[9] The stride length and swing velocity of the outer leg (further from the center of curvature) should be greater than the inner leg when walking along curved trajectories.[24] The kinematic and dynamic constraints, amplitude, and firing timings of muscle activation are more adapted in rotating locomotion than in normal straight walking.[25] Through repeated practice, the motor patterns of patients can become smoother and more automatic, which would facilitate switches between straight walking and turning.[9]

Imbalance is a frequent complaint from PD patients. The reason is because of the integration of the signals from the visual, somatosensory and vestibular system is damaged during the progress of disease.[26] The disrupted signal process leads to alteration of postural control and, thus, increases the risk of falls.[27] Appropriate assistive devices for ambulation are suggested for patients with PD. Using compensatory strategies such as hip strategy and step strategy can reduce the risk of falls.[1] Tai Chi, involving slow, controlled movement and postural maintenance,[28] is a good balance exercise for PD. Studies revealed that a 5-day Tai Chi program could improve walking speed and functional reach,[29] and 12 sessions of Tai Chi could enhance balance function.[30] Dancing to rhythmic music is an extrinsic cue to facilitate movements and produce specific movement strategies.[31] Dances such as tango can help patients to practice walking backward and weight shifting. Dancing also enhances the strength and flexibility of core muscles, and it is an excellent aerobic exercise.

Patients with PD frequently present speech abnormalities, including palilalia, stuttering, hesitancy, hypophonia, and extended pauses. Traditional speech therapy twice a week emphasizing rate, articulation, and prosody intervention have been largely ineffective for PD patients.[32] The strategy most commonly used for the treatment of dysarthria in PD patients is the Lee Silverman Voice Treatment,[33] which focuses on a set of tasks that maximize the phonatory and respiratory effort with daily intensive training sessions. Patients are encouraged to "think loud, think shout," and are stimulated to produce maximal effort during sustained phonation. They are also frequently reminded to monitor the loudness of their voice and the effort to produce it. In addition to the speech problems, dysphagia is also common in PD patients. Oral stage problems such as jaw rigidity, impaired head, and neck posture during meals, lingual tremor, and tongue-pumping behaviors frequently hamper oral food transport in PD patients.[34] Compensatory techniques such as chin-tuck swallowing for those with impaired laryngeal vestibule closure, neck extension during swallowing for impaired oral bolus propulsion, and effortful swallow for those with poor tongue base retraction should be administered to PD patients to reduce the risk of aspiration.

Formulation of a proper rehabilitation protocol requires that patients with PD have a thorough evaluation of impairment. A rehabilitation program is then prescribed according to the impairment presented. In addition to the individualized rehabilitation program, proper assistive device such as a wheeled walker could prevent accidents such as falling. Home equipment or furniture adjustment should also be done by occupational evaluation. These adjustments could help patients with PD maintain independent lifestyle at home instead of bed-ridden status. Finally, a properly designed daily home exercise program that includes proper stretching and aerobic training is the key to maintaining their activities of daily life. The above-mentioned rehabilitation protocol is summarized in Fig. 1.

3. Rehabilitation in AD

AD is a disease that progresses with age. In addition to memory loss and cognitive impairment,[35] many studies have also mentioned that AD is associated with physical deterioration, reduction of muscle mass, a high risk of falls, and loss of independence.[36, 37] Also, more than one-half of dementia patients have urinary, stool incontinence, or both.[38] Rehabilitation for AD patients provides visual, auditory and social stimulation, safety concerns, individualized hygiene habit training, and group exercise programs. Studies suggest that programs including resistance training, joint mobility exercise, and coordination exercise would improve the muscle strength, flexibility, and agility.[39] Such forms of resistance training include an elastic band, sand bag, or an individual's body weight. Cognitive rehabilitation is also an important part of intervention because impaired cognitive function is most detrimental to the quality of life of patients and their families/caregivers. Those in the early stages of AD with mild cognitive impairment show better learning ability.[40] Rehabilitation programs combining practical problem solving strategies (using a memorandum or time planner to improve self organization), cognitive training, and self-assertiveness training are suggested.[41] Reminiscence therapy, including the discussion of past experiences in tandem with the aid of photographs, household items, music and sound recordings, or other familiar items from the past has also demonstrated beneficial to the cognitive and emotional function of the patients with dementia.[42]

Intelligent assistive technologies provide new opportunities to AD patients for improving their quality of life and long-term care

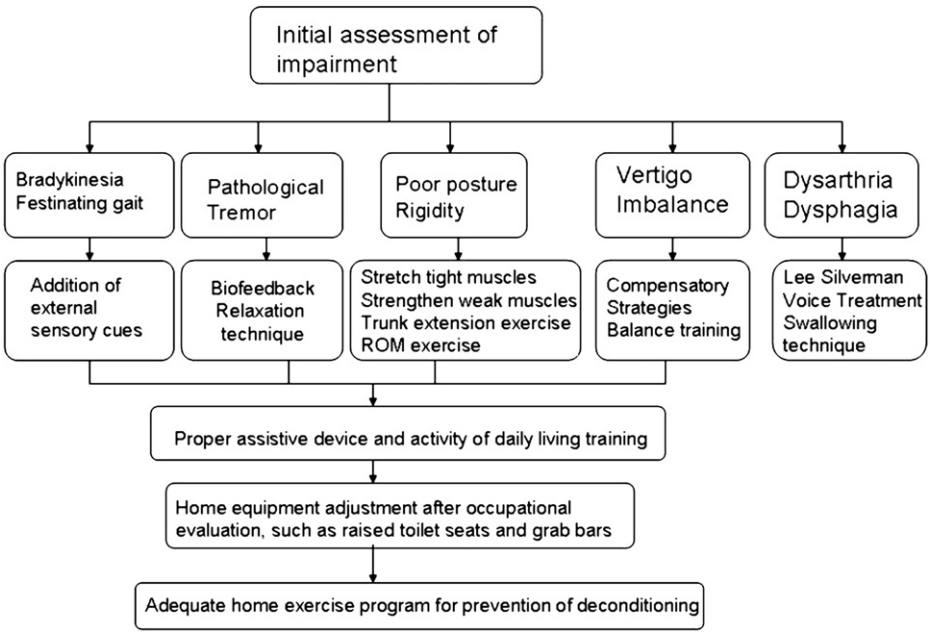

Fig. 1. Rehabilitation protocol for Parkinson disease.

ability. Technology memory aids, environment detectors, and video and audio sensors can monitor the physical activities and environmental safety of functionally impaired patients. For cognitive aid, Bharucha and others[43] found that memory glasses could capture visual images and permit contextual awareness. Cell phones with global positioning and Bluetooth can help users learn standard routes within their community.[44] A recent study used passive unobtrusive sensors such as infrared sensors to detect inactivity and falls,[45] yet the accuracy of fall detection reached only 37.5% of other laboratory experiments. Aside from the variety of device designs, individual patient needs are the main concern of clinicians, and more work must be done to link the gaps between the domains of engineering, computer science, and humanities.

In summary, rehabilitation for patients with AD should include behavior, emotional, cognition, and stimulation-orientated therapy. In addition, individualized exercise regimens are also very important to postpone physical deconditioning of the patients with dementia. Dementia is commonly encountered among patients with stroke and PD, and the protocol described here can also be applied to these patients when dementia developed as a comorbidity. The descriptions of the above therapeutic protocol are listed in Table 1.

Table 1
Rehabilitation concerns for patients with Alzheimer disease

Rehabilitation for patients with Alzheimer disease	Description
1. Behavior therapy	Emphasize individualized habit training, using memorandum as a reminder
2. Emotional intervention	Reminiscence therapy is beneficial for mood and cognition. Self-assertiveness training is also important
3. Cognitive training	Provide information about time, place, or person to improve the comprehension of the patients about their surroundings
4. Stimulation-oriented treatment	Provide visual, auditory, and sensory stimulation to delay the degeneration of memory
5. Individualized exercise program	Proper stretching and strengthening exercise could prevent rapid physical deconditioning due to memory impairment

4. Rehabilitation in stroke

The most striking symptoms of stroke patients are limb weakness and disturbed gait patterns.[46] Weakness of flexor muscles and synergistic extension motor patterns in lower limbs can lead to abnormal gait patterns.[47] These motor impairments can reduce activity levels, increase energy expenditure, and limit independence, leading to a poorer quality of life.[48] Recovery of movement and neural plasticity are predicted to be optimal in the first 3 to 6 months, and reach a plateau 6 months after stroke onset. Therefore, rehabilitation treatment should be intervened constructively as soon as possible. Recovery of movement is divided into several stages.[49] During the flaccid stage after acute onset, good positioning of the flaccid limbs is the key point of treatment. Maintaining joints ROM, muscle flexibility, prevention of joint contracture, and subluxation can be achieved through correct positioning. Range of motion exercises, proper transfer, and pressure relief techniques should be taught to families or caregivers. In patients with flaccid or low muscle tone, postural activity could be facilitated by touch and proprioceptive stimulation.[50] Assistive devices are vital in the presynergy stage.

During the synergy stage, patients usually exhibit some voluntary motion with synergistic and increased muscle tone. Facilitation of movement and inhibition of abnormal muscle tone is essential. Knott and Voss described "hidden potentials for recovery,[51]" and Bobath mentioned "some untapped potential for more highly organized activity[52]" at this stage. Therefore, the proprioceptive neuromuscular facilitation (PNF) technique and the Bobath method were developed to facilitate the potentials of the hemiplegic limbs. The PNF approach emphasizes stretch reflexes. These reflexes are frequently used to elicit movements. Mass movement patterns such as diagonal, spiral, and total patterns are integrated according to developmental sequences.[50] In the Bobath method, the first step is an appropriate reflex-inhibiting pattern for the reduction of abnormal muscle tone. The Bobath method initiates normal movements through "key points of control," and emphasizes progressive treatment according to normal developmental sequences.[50] The movement-science based physical therapy, also called the motor relearning technique, is a commonly practiced

treatment approach in stroke rehabilitation. This technique, developed by Carr and Shepherd,[53] identifies the deficits and disabilities in daily tasks and emphasizes on tailored-exercise to reconstruct specific movement patterns for enhancement of functional daily activities. One previous study has demonstrated similar outcome in both Bobath based and movement science based physical therapy in stroke patients.[54] Another training method, the so-called repetitive task training method, with focus on repetitive exercises similar to daily tasks, has also shown significant improvement in lower limb functions and activity of daily living in poststroke patients.[55] Constraint-induced movement therapy (CIMT) is another frequently used intervention. CIMT uses slings/splints to restrain the nonaffected upper extremity, and combines task-specific training of the affected limbs for 6 hours per day. This method improves the grasp and release function of the hands, and it is more useful in patients who already have isolated finger and wrist extension.[56–58] By combining an assistive device such as a quadricane, ankle-foot orthosis, and a wheelchair, patients can practice walking.

Stroke patients may have shoulder subluxation or malalignment. This is due to loss of the passive locking mechanism and support from the rotator cuff and deltoid muscles. Treatment should focus on good positioning of the scapula by PNF technique and functional electrical stimulation for facilitating muscle contraction, maintaining full pain-free range of passive shoulder movements. Type 1 complex regional pain syndrome, also known as shoulder-hand syndrome when developed in the hemiparetic upper limb in stroke patients, has been documented to be associated with shoulder subluxation.[59] The involved upper limb often experiences painful, edematous, dystrophic skin, and altered temperature/tactile sensations that can impede functional recovery of the limb to a large extent. Once the shoulder-hand syndrome is suspected clinically, three-phase bone scintigraphy should be arranged to confirm the diagnosis. Treatments including oral steroids, passive range of motion exercises as tolerated, and hemiplegia slings, and application of physical modalities should be initiated as early as possible.[60] Early and effective pain reduction is beneficial to functional recovery of the affected limb.

Due to different areas of ischemic insults after stroke, various types of aphasia including Broca's aphasia, Wernicke's aphasia, conduction aphasia, transcortical motor aphasia, transcortical sensory aphasia, and global aphasia frequently develop as a consequence. A number of strategies aiming for aphasia have been developed. One specific treatment for motor aphasia in stroke patients is the melodic intonation therapy,[61] which utilize the noninjured functioning neural pathways in the nondominant hemisphere that carry musical information. Other speech therapy including verbalization, conversational coaching, and oral reading are also important for poststroke aphasic patients. For those with dysarthria, sensory stimulation, oromotor muscle strengthening exercise, and articulatory pattern retraining are commonly practiced by speech therapists. Dysphagia is also frequently encountered after stroke attack. Changing food amounts and textures to smaller boluses of pureed foods and thick liquids is considered first. In patients with unilateral pharyngeal weakness, head turning to the weak side can guide the food bolus to the functionally intact side of pharyngeus, and thus reduce the risk of aspiration. When there is also concurrent unilateral oral muscle weakness, head tilting toward the sound side might be helpful for ingesting as well.

In conclusion, rehabilitation program for the stroke patients should begin as soon as possible after stroke attacks, and the program varies with the stage of stroke. In the flaccid stage of stroke, the goal of rehabilitation lies in prevention of complication due to the loss of muscle power in the flaccid limbs. On the other hand, the goal for the synergistic stage should be the inhibition of spasticity and synergy pattern movement, and facilitation of limbs movement that is functional. As the stages progress, further occupational rehabilitation for fine motor dexterity and activities of daily living can be started, preferably with the help of proper assistive device. Speech and swallowing training should be administered according to each patient's needs. In addition to the general rehabilitation protocols described above, an individualized rehabilitation plan according to each patient's functional status and conditions is suggested to attain optimal outcome for stroke patients. The goal of the entire rehabilitation program is gaining the patient's premorbid functional status as early as possible. The rehabilitation protocol is summarized in Fig. 2.

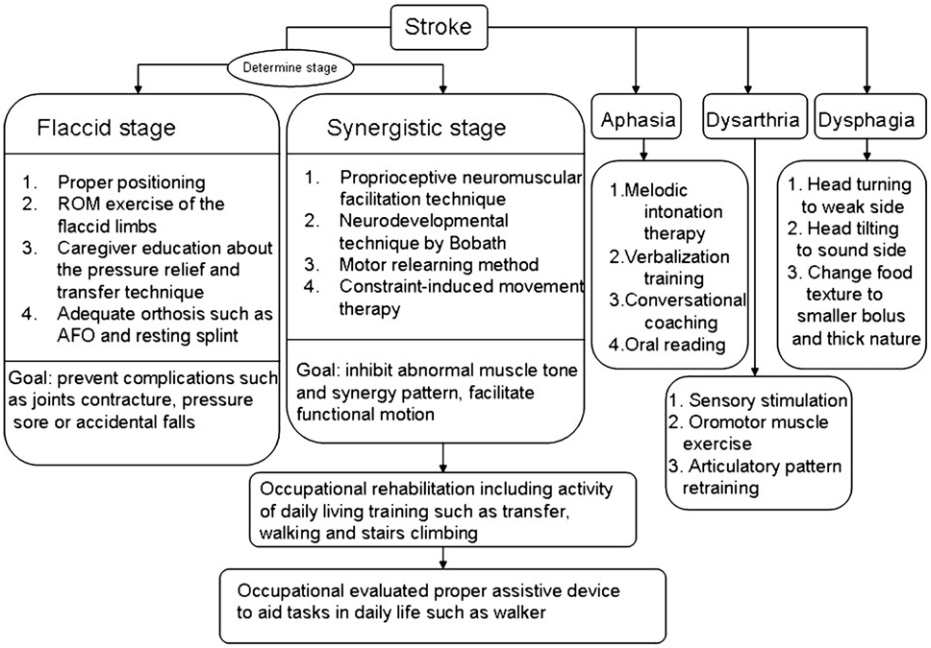

Fig. 2. Rehabilitation protocol for stroke patients.

5. Rehabilitation in vestibular disease

Dizziness is the most common reason for seeking medical help in the elderly.[62] This means that more than 15 million people suffer from such symptoms each year.[63] Dizziness has been reported in 30% of people 65 years or older,[63–65] and the severity of dizziness increases with advancing age.[66] Furthermore, dizziness in women is more common than in men.[66,67] Benign paroxysmal positional vertigo (BPPV) has been reported to be one of the most common causes of vertigo and is estimated to account for 20% to 30% of all vertigo.[68] For patients older than 65 years, the recurrence rate was found to be 1.7 times higher than in the younger age group.[69] The number of hair cells in the semicircular canals is reduced during the aging process, which leads to a reduction of excitation of the vestibular system. In addition, degeneration of vision, poor proprioception, and decreased speed of muscle contraction leads to reduced balance ability, as well as falls. Fall injury caused by dizziness is a significant problem threatening the health of the elderly. Dizziness has been strongly related to falls in the elderly, and it can predict functional decline.[70] To reduce the impact of imbalance, it is important for clinicians to treat dizzy patients. The velocities of head movements during daily activities such as running or turning are extremely high. In patients with vestibular deficits, head movements of more than 2 Hz frequency would induce dizziness, oscillopsia and imbalance. Around 35% to 77% of bilateral vestibular hypofunction patients experience oscillopsia.[71–74] Vestibular deficit patients often complain of "shopping isle syndrome." This syndrome describes the symptoms of dizziness and imbalance that occur with complicated vision, proprioception, and vestibular sense stimulation. Therefore, daily activities such as crossing the street, walking up and down stairs, and driving a vehicle can be intense challenges to individuals with vestibular deficits.

BPPV is diagnosed by the characteristic symptoms as well as observation of the patients' nystagmus during the Dix-Hallpike maneuver. If the patient reported vertigo with changing head position, and torsional nystagmus during Dix-Hallpike maneuver is observed, posterior canal involved BPPV is diagnosed. If the patient complained of vertigo when rolling in bed and horizontal nystagmus during Dix-Hallpike maneuver is observed, horizontal canal involved BPPV is diagnosed. After determining the involved canal, proper therapeutic maneuver can be applied. For posterior canal BPPV, Epley canalith-repositioning procedure[75] is done by changing the patient from sitting to lying positions while holding the patient's head and neck at an extension of 20° and rotate 45° toward the affected side. After the patient's symptoms subside, turn the patient's head to the unaffected side for 45°, and then 135° to direct the debris from the semicircular canal toward the utricle. The patient is then returned to the upright sitting position. Each of the four positions should be held until the nystagmus or vertigo symptoms subside. For the horizontal canal BPPV, the Barbeque maneuver[76] should be performed initially with the patient lying supine, and then three consecutive 90° turns toward the unaffected side. The patient must stay in the same position until the symptoms subside before proceeding to the next turn, and the entire maneuver is repeated until no symptom can be elicited by the procedure. Brandt-Daroff redistribution exercise can be educated as a home exercise as tolerated. The method of Brandt-Daroff exercise is conducted by quickly moving to the right side lying position with the head rotated 45° facing up for 30 seconds, and then the left side for another 30 seconds.

The goal of vestibular rehabilitation (VR) is to create a situation that induces symptoms and uses head, eye, and trunk coordination to habituate the situation, with a purpose to accelerate compensation mechanisms. The interventions of VR involve vestibular-visual and proprioceptive stimulation. The theory of VR is based on the central mechanism of neuroplasticity, including adaptation, substitution, habituation, and repositioning/liberatory maneuvers. The strategy of exercise is from easy movements in a comfortable environment to complex exercises in complicated situations. The therapeutic approach is to increase the interaction between vestibular and visual systems during head movement, to improve static and dynamic postural stability by changing stance postures, and to reduce sensitivities of head movements in conflicting visual surroundings. The training in vestibular rehabilitation combines repetitive head movements, increasing speed of movements, visual/vestibular interactions,[77] and balance training together. For patients of all ages, the effects of VR after 2 months of training include reduced dizziness, a decreased degree of handicap in daily activities, improvement in self confidence, and the enhancement of visual stability during locomotion or head movements.[78–81] Common exercises prescribed in vestibular rehabilitation program are dependent on the provoking reasons of vertigo. To prevent falls, postural strategy practicing exercise is recommended in all patients with vertigo. General exercises, such as stretching, strengthening, and aerobic exercises, are also important to prevent rapid physical deconditioning due to the fear of falling and the discomfort of vertigo. The summary of vestibular rehabilitation program is listed in Fig. 3.

Virtual reality has recently been applied to rehabilitation therapy in stroke and spinal cord injury patients.[82–84] Several studies applied virtual reality technology for the treatment of vestibular patients.[85–87] The common chief complaints of vestibular patients are unsteadiness, visual blurring, or space and motion discomforts, especially when walking in shopping malls, riding in moving vehicles, watching long and narrow visual scenes, or receiving complicated visual stimulation such as watching a three-dimensional movie. Virtual reality techniques provide a controlled space and patients can habituate dizziness-inducing scenes step-by-step without experiencing danger.[88] Head mounted displays are commonly used in vestibular training because of their portability and low price. Some people reported visual blurring and headache after training with the head mounted equipment,[89,90] which limits the applicability of the head-mounted systems in vestibular training. The authors found that by applying a rate sensor mounted on patient foreheads to switch on the training scenes during head movements, the adverse effects of headache and nausea were greatly reduced and the positive effects of training were significant (Kao, et al. 2011). Virtual rehabilitation increases the motivation of participation. In future studies, virtual reality without any head-mounted devices may be more realistic and more convenient for patients to receive vestibular rehabilitation.

6. General principles of exercise for the elderly

Five to 10 minutes of warmup before exercise can prevent soft tissue injuries. At least 5 minutes of cool down exercise can reduce the risk of hypotension, dizziness, muscle soreness, and rising epinephrine levels. Furthermore, clinicians need to pay attention to medication schedule and patients' vital signs during exercise. The optimal frequency of exercise for elderly people is at least three times a week to improve cardiovascular function. For enhancement of physical fitness, exercise frequency may increase to five times a week. Exercise intervention should start from mild intensity [35%–55% max heart rate (HR), rating of perceived exertion (RPE) 10–11] with gradual progress to moderate intensity (55%–65% Max HR, RPE 12–13). To avoid the increase on cardiovascular loads, isotonic and isokinetic exercises are more appropriate for the elderly than isometric exercise.[91] To promote the motivation to exercise, group exercises with eight to 10 members

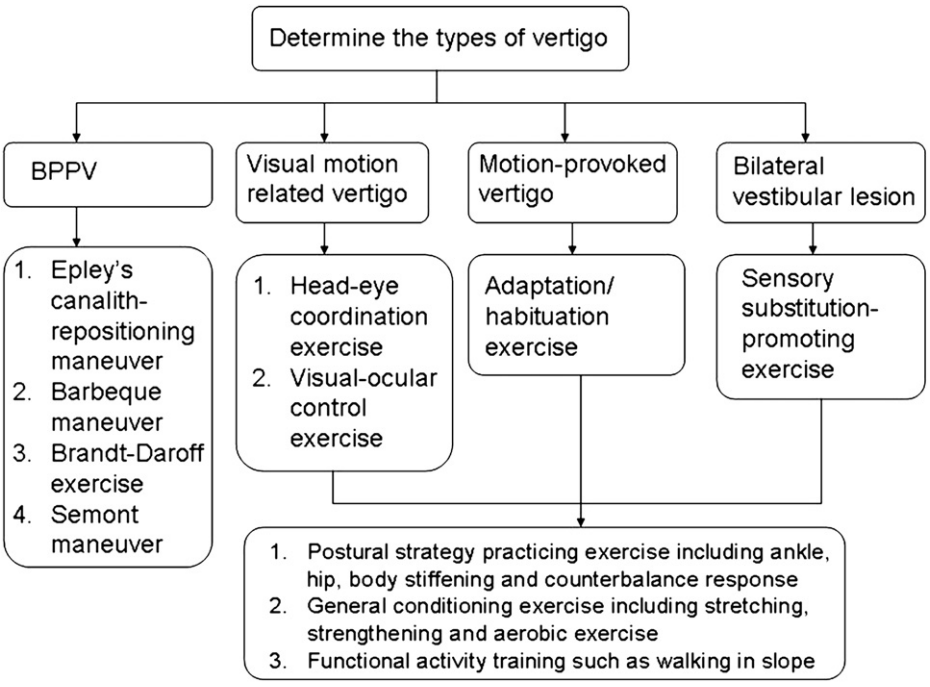

Fig. 3. Rehabilitation protocol for vestibular disease.

and rhythmic movements can be more entertaining. Appropriate exercises for elderly people are described in the following subsections.

7. Stretching exercises

Appropriate stretching exercises can improve flexibility.[92] Flexibility means the movement range of one joint or multiple joints.[93] Increasing flexibility can prevent muscular-skeletal injuries,[94] reduce soreness, decrease the risk of falls, and is also useful for maintaining and improving range of motion. Studies have shown that a stretch should be maintained for 30 seconds and repeated three to four times.[95] The force of stretch should be low and progressive,[96] and the stretch angle should be increased slowly. When performing stretching exercises, it is acceptable to feel slightly painful or tight; however, overstretching may cause muscle injury. Studies also pointed out that active stretching is better for the elderly.[97]

8. Strengthening exercises

Berger and colleagues[98] pointed out that physiologic functions decline with advancing age and only 50% of the decrement is due to the ageing process—the other 50% being due to disuse. To prevent disused muscle atrophy, elderly people must maintain a regular exercise habit, with an emphasis on lower extremity muscle strength for fall prevention. Instead of train a single muscle group at a time, it is suggested that the agonist muscles, synergist muscles, and antagonist muscles are trained in equilibrium.[96] Resistance training in a rhythmical manner at a slow controlled speed can prevent blood pressure elevation and decrease load on the cardiopulmonary system.[97] The new recommendations from the American Heart Association suggest eight to 10 sets of 10 to 15 repetitions at reduced levels of resistance for the elderly.[99] The frequency of strengthening exercises should be at least three times a week to keep the training effect.[100]

9. Walking

Elderly people often feel unwilling to engage in formal exercise training. Therefore, walking can be encouraged because it is a moderate physical activity, and it is commonly acceptable for people with a sedentary lifestyle and for the elderly.[101] Walking can improve lower extremity and back muscle strength, increase the flexibility of main joints, and enhance balance.[102] Walking is a form of aerobic exercise and is helpful for prevention of arteriosclerosis. The appropriate duration of walking is suggested to be 30 minutes a day.

10. New rehabilitation interventions in the elderly

In addition to conventional rehabilitation training programs, vibration training, video-game-based rehabilitation, and Tai Chi are interventions that have been used in recent years. Whole-body vibration training applies a vibration plate to distal parts of muscles; thus, the sensation of indirect vibration can be passed on to train muscle groups throughout the body. Vibration training may be an alternative for promoting muscle strength and power, increasing flexibility, as well as preventing osteoporosis.[103] When applied to the human body, lower frequencies and lower amplitudes are safer and more effective for skeletal muscular structure training.[104] Higher frequencies and lower amplitude stimulations are helpful for improvement of muscle strength, balance ability, and reduction of fall and fracture incidence.[105] However, more investigation needs to be done to determine the optimal frequency and amplitude for training.

The most well known video-game–based rehabilitation recently is Wii Fit (Nintendo Co., Ltd, Kyoto, Japan). A great deal of simultaneous head/trunk turning and weight shifting is required when playing Wii Fit games. One previous study has shown that playing Wii Fit could provide health promotion and physical benefits, including mobility, dexterity, range of motion, coordination, and distraction from pain, as well as psychological gains such as social engagement, self-esteem, mastery, and ability to pacify

challenging behaviors in the elderly and those with disabilities.[106] Another study combined virtual reality and the Wii and demonstrated safety and effectiveness in training motor function as an adjunct to traditional stroke rehabilitation.[107] More video-game–based rehabilitation protocols utilizing in a variety of neurodegenerative disease is warranted in the future.

Tai Chi, a traditional exercise for hundreds of years, has transformed into balance exercise training for patients with balance disorders in recent years. It is an exercise that suits all ages. The slow body movement of Tai Chi emphasizes the sensation of weight shifting. Individuals can adjust the contexts and movements depending on their own ability. Research has shown that practicing Tai Chi promotes endurance and balance,[108] decreases the incidence of falls and reduces the fear of falling, as well as improving coordination ability.[109] Older people who have regularly practiced Tai Chi exhibit better flexibility, cardiovascular fitness,[110] and improved proprioception.[111] The reasons for the enhancement of function with Tai Chi are that the exercise combines strengthening, balance, postural alignment, and concentration programs, improving self-awareness of the body. It is also useful for the reduction of joint pain, making Tai Chi particularly beneficial for the elderly.

11. Conclusion

Chronic neurologic diseases in the elderly population represent a challenging issue for health care providers. Older people may have subclinical comorbidities that had been sustained years before. The compensation abilities to cope with physical or psychological insults decrease as people age, which frequently result in disabilities with a single acute disease. Elderly individuals often present with comorbidities such as osteoarthritis of the major joints of lower limbs and decreased cardiovascular endurance secondary as well as atherosclerosis or chronic obstructive pulmonary disease. Despite general principles of rehabilitation for each chronic neurologic disease described as above, comorbidities such as pain and dyspnea during exercise should be managed first and always kept in mind. The impact of pain and dyspnea differs with the severity of osteoarthritis and cardiopulmonary disease in each patient; therefore, the progression of rehabilitation program always needs to be individualized according to the comorbidities presented. Rehabilitation can improve physical and mental function, life quality, and achieve optimal recovery in the older population with chronic neurologic diseases.

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