2016

Lessons and challenges of trials involving ancillary therapies for Parkinson’s disease

Chris J. Hass

Elizabeth L. Stegemoller  
iowa State University, esteg@iastate.edu

Madeleine E. Hackney

Joe R. Nocera

Follow this and additional works at: http://lib.dr.iastate.edu/kin_pubs

Part of the Exercise Science Commons, Motor Control Commons, and the Psychology of Movement Commons

The complete bibliographic information for this item can be found at http://lib.dr.iastate.edu/kin_pubs/23. For information on how to cite this item, please visit http://lib.dr.iastate.edu/howtocite.html.

This Book Chapter is brought to you for free and open access by the Kinesiology at Iowa State University Digital Repository. It has been accepted for inclusion in Kinesiology Publications by an authorized administrator of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.
Lessons and challenges of trials involving ancillary therapies for Parkinson’s disease

Abstract
Progressive impairment, particularly related to gait, postural control and cognitive decline, are not effectively treated by the current pharmacological and surgical management of Parkinson’s disease (PD). This has led many patients and treating physicians to explore concomitant therapeutic modalities such as aerobic exercise, resistance training, physical therapy, massage, dance and music therapy, tai chi and others to aid in reducing symptomatology and improving patient quality of life.

Disciplines
Exercise Science | Kinesiology | Motor Control | Psychology of Movement

Comments

This book chapter is available at Iowa State University Digital Repository: http://lib.dr.iastate.edu/kin_pubs/23
short-term relief of sialoerous symptoms in Parkinson's disease patients [1310:28–50].


---

**Chapter 32**

**Lessons and challenges of trials involving ancillary therapies for the management of Parkinson's disease**

Chris J. Hass, Elizabeth L. Stegemöller, Madeleine E. Hackney and Joe R. Nocera

**Introduction**

Progressive impairment, particularly related to gait, postural control and cognitive decline, are not effectively treated by the current pharmacological and surgical management of Parkinson's disease (PD). This has led many patients and treating physicians to explore concomitant therapeutic modalities such as aerobic exercise, resistance training, physical therapy, massage, dance and music therapy, tai chi and others to aid in reducing symptomaticity and improving patient quality of life. Over the last 15 years, the research community has also experienced an explosion of efforts into studying the efficacy of exercise interventions on motor and nonmotor symptoms as well as their ability to enhance patient well-being. For example, in the decade preceding 2004, there were roughly 10–15 papers published per year related to exercise in PD. From 2004 to 2013, this number skyrocketed to an average of 50 papers per year. With this progression of efforts, the quality and ingenuity of treatment paradigms have expanded from small pilot studies of walking and weight training to large multicenter trials investigating robotic-assisted cycling and exercises paired with brain-stimulation techniques. In general, many of the abovementioned accessory treatment treatments have proven moderately effective. However, issues with study designs, small sample sizes and heterogeneous outcome measures coupled with the trials and tribulations of prescribing these treatments to the heterogeneous PD community have largely prevented a major contribution of these therapies to advances in the treatment of PD. Although the evidence from the animal literature is quite compelling with respect to neuroprotective and neuroplastic benefits of exercise, as well as the ability of different exercises to result in differential effects on the nervous system, these effects in humans have been more difficult to demonstrate. In this chapter, we will outline the effectiveness of the more popular movement and behavioral therapies on the treatment of motor and nonmotor features of PD.

**Aerobic exercise**

Aerobic exercise improves a wide range of functional outcomes in individuals with PD. Indeed, individuals with PD benefit from aerobic exercise as much as healthy older adults [1, 2]. In fact, aerobic exercise interventions may represent one of the best ways to prevent disability and secondary complications associated with PD [3]. For example, multiple studies examining 16-week aerobic exercise training regimens have reported improvements in oxygen consumption (VO2) consistent with a healthier and more efficient cardiovascular system, improved scores on the Unified Parkinson's Disease Rating Scale (UPDRS), and improved performance on physical function performance tests and movement initiation [4]. Specifically, Bergen et al. [5] demonstrated a 26% improvement in peak VO2 among PD patients follow aerobic training. Additionally, improved walking economy has been noted in individuals with PD who participated in aerobic activity [6]. When compared with other forms of exercise, aerobic interventions have demonstrated a greater improvement on select facets of physical function. For example, when compared with a medical Chinese exercise (qigong), Burini et al. [7] demonstrated that aerobic training exerted a significant impact on moderately disabled PD patients in functional parameters.
including, the 6-min walk test, Borg scale and cardiopulmonary outcomes (peak VO2).}

Studies from animal models suggest that aerobic exercise may not only have effects on physical function — it may also interfere with the disease process itself. For example, treadmill or wheel running initiated soon after a unilateral 6-hydroxydopamine (6-OHDA) lesion reduced neuromotoric loss, lessened forelimb motoneuron loss and reduced dopaminergic loss when compared with sedentary lesioned rats [8]. Forced-exercise paradigms, in which the animal has to maintain a running velocity that is greater than their preferred running speed, have also been studied. Results from forced-exercise paradigms in animals demonstrate short- and long-term improvements in forelimb akinesia, stride length and step length, as well as sparing of striatal dopamine compared with sedentary lesioned animals [8, 9]. Similarly, Poulton and Muir [10] reported that forced treadmill running accelerated dopamine loss in 6-OHDA rats.

Forced aerobic exercise in the human PD condition has demonstrated equally intriguing results. Ridgell et al. [11] randomly assigned ten mild to moderate PD patients to either 8-weeks of forced exercise or voluntary exercise. Patients in the forced-exercise group pedaled on a stationary tandem bicycle with the assistance of a trainer at a rate 30% greater than their preferred voluntary rate. Patients randomized to the voluntary group pedaled at their preferred rate. The results demonstrated that the forced-exercise group improved their UPDRS motor score by 35%. Interestingly, improvements in coordination of grasping forces during the performance of a functional bimanual dexterity task improved in PD patients in the forced-exercise group, suggesting improved central motor function.

Another promising aerobic intervention for PD patients is treadmill/gait training. Patients with PD who have undergone gait training on a treadmill have shown improvements in UPDRS motor scores, increased gait speed and cadence during walking, and reductions in the number of falls [12, 13]. Research examining progressive speed-dependent treadmill training showed an improvement in gait speed and stride length of walking in early PD when compared with conventional gait therapy [14].

Unfortunately, despite being classified as a movement disorder, cognitive deficits are present in a large percentage of PD patients and greatly impact on function and quality of life. Cognitive deficits in PD affect complex working memory (WM), the ability to store and manipulate information held in memory, and the ability to store information despite distraction [15]. In addition, a wide range of executive function abilities, including planning, inhibitory processes and set-shifting, are impaired in PD [16–18]. Interestingly, recent work from the healthier older-adult literature [19, 20] suggests that aerobic exercise and/or cardiovascular fitness may reverse age-related cognitive decline and facilitate a healthy cortex. For example, Colcombe et al. [21] demonstrated that older adults with greater levels of cardiovascular fitness have significantly less atrophy of the gray matter in the frontal cortex, which typically shows the greatest age-related decline [22]. Furthermore, greater aerobic fitness is associated with sparing of age-related deterioration of the anterior and posterior white-matter tracts. Several other randomized controlled trials report that aerobic exercise has its greatest effects on improving the frontal cognitive processes, which are greatly impacted in PD.

While the above studies illustrate that aerobic exercise combats cognitive decline in healthy aging, the potential impact of aerobic exercise on cognitive changes in PD has not been studied thoroughly. Preliminary data are indeed encouraging, as results from a case study by Nocera et al. [23] demonstrated that a patient with PD was able to improve on cognitive outcomes including executive and language processes following an aerobic exercise intervention. This work suggests improvements in brain health in PD similar to that of older adults who participate in aerobic exercise. However, larger randomized trials are warranted to evaluate the efficacy of aerobic exercise for ameliorating declines in cognitive performance in people with PD.

The work described above suggests that aerobic exercise can be an effective way to prevent disability in PD patients, as it targets critical functional areas impacted by the disease. For example, the lack of critical cognitive function in particular types of aerobic exercise to be tailored to the specific needs of the patient. Furthermore, care must be taken to have a complete understanding of the fall risk and cardiac symptomatology of the patient such that safe guards can be implemented and the risk lessened. Future studies need to address issues that currently plague aerobic training, including sample size, optimal state and timing of medication, as well as how more alternative, perhaps forced-exercise, models, can be implemented and have an impact on those further along in the disease process.

Resistance training

While improvements in cognitive and physical function are observed following traditional aerobic exercise (treadmill training), recent reviews suggest that the most supportive evidence for therapeutic benefits are based on interventions incorporating strength training [24, 25]. Decrements in muscular strength have negative consequences on the performance of activities of daily living (ADLs) such as getting out of a chair or putting away groceries on a shelf above chest height. Other tasks that depend on physical activity, deconditioning, increased frailty and dependence on the services of others. The quantity and quality of muscle mass and strength impacts numerous aspects of daily performance in older adults and people with PD such as walking speed, stair negotiation, avoiding obstacles, chair rise, and recovering from slips and trips. Recent comprehensive reviews suggest that the progression of these losses may be attenuated or at least slowed through regular resistance training exercise [24, 25]. We suggest that resistance training is safe, effective and noninvasive way of reducing the symptoms of the disease that gives patients an active role in the management of their disease, yet we know little about the mechanisms by which such benefits are achieved.

Several of the neural consequences and symptoms of PD reinforce the rationale for providing resistance training to patients [26]. First, loss of muscle strength is frequently observed, particularly in the muscles surrounding the hip, knee and ankle in both the unmedi cated and medicated state. Furthermore, loss of muscle strength contributes to bradykinesia and reduced balance capabilities during dynamic locomotor tasks. In addition to loss of strength, PD researchers observe a reduction in the ability to produce force rapidly, which is particularly important when trying to take a recovery step after a stumble or reaching out the arm to grab a handrail to prevent a fall. Torque production has also been shown to vary with movement velocity, with particular deficits between the more- and less-affected side becoming pronounced at fast movement speeds. Aberrant muscle activation patterns are frequently observed during single joint and functional movement tasks. These abnormal activation patterns are likely related to impairments in variability, intensity and frequency of the corticospinal activation of the muscle. It is unclear, however, if these changes that are seen in muscular performance are solely related to changes at the periphery (muscle mass), impaired corticospinal activation, consequences of overall diminished activity or a combination of all of the above [26]. The peripheral and central neural adaptations that occur with resistance training may improve these decrements. Indeed, evidence suggests that resistance training can enhance cortical plasticity, improve descending activation of the motor cortex, lessen nigrostriatal, striatal and ganglia nuclei, alter functional properties of spinal cord circuitry and cross-transfer training effects from the trained to untrained limb [26]. Despite recommendations for the inclusion of strength training into PD treatment more than 20 years ago [27], very few well controlled investigations exist on this topic.

The extant literature suggests that resistance training can improve muscle mass, muscle strength and muscular endurance as well as neuromuscular function for patients with PD. Importantly, concomitant with these enhancements were observed reductions in parkinsonian disability. Cainsoud et al. [28] observed a 7-point reduction in UPDRS motor scores following 24 months of twice-weekly resistance training. Also of note was that physical training was done at the participants’ own gym and not in a strict laboratory setting. Due to disease-related cost and travel limitations, gym- and laboratory-based exercise programs may not be feasible for all individuals. Importantly, we have shown that home-based exercise intervention focusing on lower-extremity strength can also improve muscle performance that carries over to enhanced balance, as measured by computerized dynamic posturography [29]. As with any exercise modality, it is important to the patient to see that becoming bigger, stronger and faster carries over to enhance functional performance.

Work from our laboratories and others have shown that resistance training in PD can lead to improvements in gait, gait initiation, chair rise, stair stepping, postural control [30], gait speed, step length and head posture all improve following training, as well as functional gait outcomes such as walking endurance during the 6-min walk and improved timed performance on timed up-and-go and stair ascent and descent. Resistance training also improves anticipatory postural adjustments during initiation to larger and faster steps. Similarly, resistance training improves not only the speed of chair rise, but also the biomechanical mechanisms for safe and efficient performance. After resistance training, people with PD also demonstrate an improved ability to...
maintain balance during quiet and destabilizing bal-
ance conditions. Lastly, these improvements in muscu-
lar and functional performance lead to improvements in patient-perceived quality of life.

As with many therapeutic interventions, the pre-
sent state of knowledge is impacted by several limi-
tations that influence our ability to prescribe resistance training to our patients. First, the extant literature is plagued by small sample sizes and a potpourri of out-
come measures that, while supporting a broad range effect, also limit our understanding of mechanisms and the ability to target disease-specific manifestations. Furthermore, the true benefits of resistance training are likely masked by evaluation of PD patients in the optimally medicated state. This practice has several ramifications, including masking the effects of train-
ing on the disease itself, as well as reducing effect sizes, which influences statistical findings and the con-
clusions with respect to efficacy. While much of the research has focused on motor benefits in PD, non-
motor features of the disease may also be impacted by resistance training. For example, resistance training in older adults facilitates general cognition. In fact, resist-
ance training, personal training, and cognitive training that involves executive control, which, as stated previ-
ously, is particularly impacted by PD. The influence of resistance training on affective domains relevant to PD such as depression and apathy are also poorly studied.

The long-term effects of progressive resistance exer-
cise are yet to be determined, as well as the interactive effects of music and physical activity as part of a comprehensive exercise program including aero-
bic training and stretching. Furthermore, the optimal prescription of resistance training including the num-
ber and types of exercises (machines vs free weights, number of repetitions and sets) is understudied. Lastly, future research should evaluate the benefits of resist-
ance training in the context of the different clinical subtypes of individuals with PD. In spite of these limi-
tations, the literature supports the recommendation of resistance training for patients with PD.

Tai chi

In the healthy older-adult literature, tai chi exercise has gained attention as an attractive intervention because of its potential to reduce falls and improve postural control and walking abilities, while also being safe and at a low cost. Tai chi was first evaluated as a complement-
tary therapy for PD motor symptoms with a case study examining the progress of two 66-year-old males with PD who demonstrated balance improvements after a 3-month fitness program, which involved balance, unsupervised activity at a fitness center and twice-
weekly tai chi sessions [2]. A later study, with more focus on tai chi, revealed that an intensive 5-day tai chi program in 17 individuals with mild to moderate PD resulted in improvements in mobility and flexibility, as well as satisfaction and enjoyment with the program [32]. Hackney and Earhart [33] stud-
ied 13 individuals with PD who completed 20 1 h les-
sions of tai chi and compared them with an untreated control group. The findings demonstrated that those who participated in tai chi developed improvements in the Berg balance scale, disease severity, mobility, static balance, endurance and backward walking.

To date, the strongest evidence that tai chi may improve motor impairments related to PD has been provided by a randomized controlled trial that assigned 195 participants to one of the following groups: tai chi, resistance training or stretching (24 weeks, 1 h, twice weekly) [34]. Follow-up analysis revealed that the tai chi group performed consistently better than the resistance training and stretching groups in maximum excursion test. The tai chi group also performed significantly better when compared with the stretching group in measures of gait and strength, scores on functional reach and timed up-and-
go tests, and motor scores on the UPDRS. Additionally, the tai chi group improved compared with the resist-
ance training group in stride length and functional reach. Last but not least, the incidence of falls was lower compared with stretching but not resistance training, and the effects were maintained 3 months later. A note-
worthy flaw in this study, however, is that the resistance training was very low intensity.

Interestingly, not all PD-related motor outcomes have benefited from tai chi. For example, Amano et al. [35] investigated the effect of tai chi exercise on dynamic postural control during gait initiation and gait perfor-
mance in people with idiopathic PD. In this multisite investigation, two separate tai chi groups completed 16-weeks of supervised tai chi exercise, while the con-
trol groups consisted of either a placebo (i.e. qigong) or no 

The results indicated that tai chi did not significantly improve the UPDRS motor score, selected gait initiation parameters or gait performance. Combined results from both tai chi groups in this study suggested that 16 weeks of class-based tai chi were ineffective in improving gait initiation or gait performance, or reducing parkinsonian disability in people with PD.

Because tai chi is a form of physical activity that demands high cognitive involvement, it may serve as an effective modality for nonmotor symptoms of PD beyond the proven motor outcomes. Interestingly, Lam et al. [36] demonstrated that 1 year of tai chi training significantly improved nonmotor function but also visual attention in older adults at risk of progress-
ive cognitive decline. They hypothesized that "apart from being a form of physical activity, Tai Chi demands memory training for the complex motor sequences, as well as coordinated pathway between attention, volun-

tary motor action, postural control, verbal, and visuo-

imagery which provides increased cognitive stimula-

tion." Additionally, tai chi appears to lower feelings of stress and increase vigor in patient populations.

Specific to PD, we demonstrated the tai chi three times weekly for 16 weeks significantly improved scores on the 39-item Parkinson’s Disease Questionnaire (PDQ-
39) summary index, as well as the emotional well-being subscore when compared with a control group.

A difficult and important element to implement-

ing any life style intervention is to ensure adherence and track attrition. Previous studies examining the use of tai chi in various populations have not tested the suc-

cess with participants adhering to the program [33]. In a study by Nocera et al. [37], 92% attendance was reported. Equally important to consider is that previ-

ous studies have been unable to determine ideal dos-
age and length of tai chi intervention in PD. Future research is needed to address how tai chi implementa-
tion reaches to achieve its full potential and maximizes its effect in the general PD population.

In summation, tai chi appears to appear to reduce balance impairments in patients with mild to moder-
ate PD, with additional benefits of improved functional capacity and reduced falls. Furthermore, tai chi may have implications for the nonmotor symptoms asso-
ciated with PD. Importantly, it also appears to be well 
tolerated by individuals with PD, as few adverse events have been reported, and adherence and self-reported satisfaction are high. It is important to note, however, that not all studies have concluded physical improve-

ment with tai chi exercise in people with PD. Future research is needed to identify the ideal dose response and which motor and nonmotor aspects of PD can be maximized with tai chi.

**Massage/acupuncture**

Patients with PD also resort to other complement-
ary and alternative medicines in hopes of improving quality of life and motor symptoms. Indeed, previous reports suggest that 40% of patients use some form of alternative therapy, with massage therapy and acu-

upuncture being among the most common [38]. Several studies have shown that routine massage therapy services helped to improve performance in levels of ADLs, improved sleep quantity and quality, and lower levels of stress hormones [39]. Unfortunately, mechanism-based research in this area is lacking. Conversely, acupuncture stimulation in PD models suggests that acupuncture may have neuroprotective benefits through the release of various neuroprotector-

tive agents such as brain-derived neurotrophic factor, glial cell line-derived neurotrophic factor and cyclo-

philin A [40]. In an 8-week duration human trial, acupuncture led to a reduction in disease severity and reduced depressive symptoms [41]. However, sham-

controlled clinical trials that adhere to the CONSORT (Consolidated Standards of Reporting Trials) and STRICTA (Standards for Reporting Interventions in Clinical Trials of Acupuncture) guidelines are strongly needed to confirm the precise effect of acupuncture on PD [42].

**Creative arts therapies**

The use of creative arts therapies in the treatment of PD has become popular over the last decade. Complementary therapies including music therapy and dance therapy provide treatment for both the motor and nonmotor complications of PD while tail-

oring to patient-specific needs and interests. While research remains limited in these areas, support is gaining for the incorporation of creative arts therapies in treatment of PD.

**Music therapy**

Music therapy is the use of music within a therapeutic relationship to address diverse cognitive and social needs of individuals. When treating peo-

ple with PD, music therapists often focus on two major areas; improving movement and voice performance.

To improve movement performance, the music therapist may incorporate the use of various instru-

ments. Music therapists are skilled at adapting instruc-

tion and use of the instruments to meet specific therapeutic needs. For example, a person with PD may be learning to play the piano or guitar to improve fine 

motor and bilateral coordination, or a person with PD may be playing jingle bells fixed to their walker to increase the range of motion for hip flexion. In both
examples, one of the most beneficial elements to music therapy is the use of external cues. Abundant evidence demonstrates that the benefits of task walking in people with SCI exploits external cueing [43, 44]. External cueing has improved movement initiation [45, 46], while additional research has shown that people with PD have faster reaction times when externally cued compared with self-initiated movement [47]. Synchronizing movement can also enhance movement and improve gait speed [48]. Yet there remains little explanation regarding the neurophysiological basis for these improvements. Currently, it is suggested that the use of external cues accesses a cerebellar–premotor cortical circuitry, bypassing the basal ganglia–supplementary motor area circuitry typically active during self-initiated movements [39]. Thus, music therapy programs that include external cues in combination with consistent rhythmic auditory stimulation are recommended for people with PD.

Auditory cues, another focus of music therapy, have also been shown to facilitate gait. Research has consistently shown that gait training with regular external rhythmic auditory cues improved gait velocity, stride length, step cadence, timing of EMG patterns and mobility in people with PD. Less is known, however, about the effects of music on gait in PD. Often, the results attributed to the facilitation of normal gait with auditory cues are extended to include music because of the similarity between the stimuli. However, only one study has examined the effects of music on gait training in people with PD, and this similarly revealed improved gait velocity, stride time and cadence. Interestingly, however, the use of auditory cues during more complex walking tasks task walking in an obstacle crossing demonstrates similar positive effects on gait, but listening to music while completing these challenging walking tasks may be attention demanding and has negative effects on gait [8, 49]. This evidence provides a conundrum, as there are several anecdotal reports of people with PD who use music to improve their gait, especially when powered environmental conditions, such as the mall or park, that involve dual tasking. Perhaps the focus of the attentional demand should be an area of consideration. In environments where minimizing external distractions is needed for effective ambulation, focusing on walking with music may be beneficial. People with PD may be able to focus more on the walking by synchronizing movement with the music. In contrast, in environments where attention is needed to complete additional tasks while walking, focusing on the additional task may be more beneficial. In these cases, music may indeed be distracting and hinder a new learning performance. Continued research on the appropriate use of music therapy in which to use music to facilitate gait is needed and will aid in determining appropriate music therapy strategies for gait disturbances in people with PD.

Group singing has also been used in music therapy for speech impairments in PD. Previous research has revealed that people with PD report improvements in gait in PD. Improvements in maximum inspiratory and expiratory pressure, voice range, speech intelligibility and vocal intensity have been reported after group singing interventions [50]. However, Shih et al. [51] revealed that group singing did not demonstrate improvements in objective measures of voice and speech impairment. A possible explanation for these differences in results may be attributed to the type of instruction being provided. When participating in group singing, specific elements such as learning the words, melody and rhythm could be emphasized over the proper singing technique (i.e., breath support and posture). Thus, the effects of group singing may match the training emphasis: improved working memory for learning a song versus improved voice for proper singing technique. Given that people with PD experience both cognitive and voice deficits, a combination of both may prove to be most beneficial. Yet no study has examined the effects of group singing on cognitive abilities in people with PD. There are additional elements that music may influence (social, quality of life) that have yet to be examined in group singing. Overall, the effects of group singing in people with PD have been underexplored, and there remains a need to better understand the potential benefits of group singing on the voice and on additional related measures. However, the fact that group singing may be able to target multiple treatment aspects such as cognition, socialization and voice performance at one time makes exploring how most effectively incorporate group singing into the music therapy treatment plan essential for people with PD to walk in an environment.

Music therapists may also directly treat additional areas such as relaxation, cognition, emotional well-being and socialization. Music has been found to activate specific neural pathways associated with emotion and may enhance social relationships. In a study of students performing to musical cues, 14 participants with PD experienced improvements in the PDQ-39 subscales of emotional well-being, stigma, bodily discomfort, mobility and ADLs [52]. Additionally, music therapy involving rhythmic body movements demonstrably improved scores on the Parkinson's Disease Quality of Life questionnaire [53]. While research shows the use of music therapy in the treatment of nonmotor symptoms is limited, treating the whole person is very valuable and is recommended in the treatment of people with PD. In fact, it is virtually impossible for a music therapist to treat only one independent objective given the innate emotional and social context associated with music that is impossible to remove. Thus, music therapists tailor the therapeutic experience by using patient-specific music to treat the whole person.

Dance therapy

Effective motor rehabilitation should be safe, be participant friendly, promote high adherence and have demonstrated efficacy in improving disease severity, mobility and quality of life. Traditional exercise programs often suffer from high attrition rates because of high patient task demand and lack of social interaction. Ideally, exercise activities should engage and sustain interest, because 60% of all Americans older than 65 do not achieve the recommended daily amounts of physical activity. Activity levels in individuals with PD are further reduced [54]. However, dance, which is a robust activity that involves mental and physical engagement and coordinating movements to music, when used as a therapeutic tool, may garner adherence through an enjoyable activity. Social and partnered dance could foster community involvement and social support while—crucially—necessitating the practice of dynamic balance and adjustment to environment, both of which are key to rehabilitating balance and axial impairments [55]. Group social dance can enhance motivation to be active and pursue healthy, exercise-related behaviors in older individuals [56, 57]. Older adults who participated in dance also demonstrated improved balance and functional mobility [58]. Greater improvements have been reported in older adult gait tasks in older adults who participated in an Argentine tango group than in a walking group [59]. While unconventional as an approach to balance and gait problems for older and/or physically challenged individuals, dance may be appropriate and pleasurable as a therapeutic activity because of its benefits to physical, mental and emotional states.

Recently, a series of studies have investigated the effects of adapted Argentine tango dance (adapted tango) for individuals with PD (Hoehn and Yahr stages 2–4). Participants experienced significant gains in mobility, balance and quality of life, improvements that are relevant in the context of motor disability. Furthermore, the participants were supported by a group of people acting as volunteers who, on average, participated in 1 year of tango classes offered in the community, participating with PD also demonstrated decreased disease severity [63]. Recently, a study demonstrated that a 12-week adapted tango program, which was disseminated to several novice instructors and offered in two community settings, improved disease severity in participants with mild to moderate PD. These improvements were maintained 3 months after cessation of the intervention [64].

Other forms of dance besides tango have been investigated for efficacy for those with PD. A study that investigated the feasibility of Irish set dancing, in comparison with standard physiotherapy, found the dancing safe and feasible. Furthermore, participants tended to improve more in gait, balance and freezing of gait after dancing than after the standard care [65]. Dance may have an immediate effect on mobility in those with PD, as improvements have been found with as little as 2 weeks of tango [66] and contact improvisation training [67]. The UPDRS score, i.e., disease severity, has also been improved in the very short term—after single dance sessions—in before/after contemporary dance class assessments [68]. This same study also reported improved health-related quality of life (HRQoL) for the PD participants as well as for their caregivers.

Other studies examining dance for its therapeutic effects on PD also noted improvements in HRQoL that often accompanied improved motor function. Improvements in HRQoL were found in a participant with PD (Hoehn and Yahr stage 5) who was severely mobility impaired, who demonstrated that even those with end-stage disease could benefit from and enjoy a modified dance class [69]. In a mixed-methods study examining the effects of a ballet class that included participants with PD, the participants reported being highly motivated and valued dance classes. Participants reported improvements in social interactions, in connection with physically active PD participants, in addition to improvements in balance, social interaction was evident, as participants were observed staying after class to socialize with peers. Modern dance in the guise of the very popular Dance for PD class format, started by the Mark Morris Dance Company, has also been shown to positively influence HRQoL in those with PD. A study found improvements in social support after 10 weeks, and improvements in activity participation were noted after 12 months of tango dance.
Although several studies have demonstrated the effectiveness of dance for improving both mobility and HRQoL, there is a need for a clearer definition to definitively determine the effectiveness of dance. Importantly, it is also necessary to conduct studies to determine the underlying mechanisms of rehabilitative dance for those with PD. Some possibilities will be introduced in the following paragraphs.

Movement strategies involving strong cognitive involvement and reading are associated with mobility improvements [71]. While learning and practicing dance, one focuses on critical movement aspects (e.g., longer steps or quicker movements), an attentional strategy that may help individuals with PD to achieve nearly normal speed and amplitude [72]. For individuals with PD, having complex movements broken down into simpler elements by the teacher, which would be done in any dance pedagogy, may facilitate motor performance [71]. A dancing partner may enhance balance, as even light touch contact can augment postural control. Improvements achieved via dance may also have resulted because dance addresses PD motor impairments through exploiting external auditory cues, which enhance motor therapy.

Participation, defined as involvement in a life situation, is related to mobility-related HRQoL, and the ability to do functional tasks like rising from a chair. Participation in a year-long program of tango led to participants recovering lost activities, beginning new ones and having the ability to engage in more complex activities [73]. Potentially, individuals with PD have benefited in HRQoL through dance by the removal of barriers to participation (e.g., availability of dance programs, motor challenges of the steps). Older adults have benefited from regular aerobic activity in terms of plasticity-related changes in synaptic plasticity, angiogenesis and neurogenesis. There is a strong link between activity, mental engagement and neural pathways. Dancing, whether it be tango, contemporary or folk dance, involves complex, unfamiliar tasks like walking backwards, allowing for problem solving and movement improvisation, possibly targetting mobility issues in individuals with PD through increased mental engagement and strategy development. The creativity involved in a dance form might tap into mechanisms of neural plasticity for novices just beginning motor therapy. The exposure to novel steps and choreographic patterns could be fostered for expanding neural areas and improving neural pathways. The neuroprotection and neurorestoration that may be derived from tango-like specific and frequent exercises could be provided by dance, and may extend into improved mobility and, ultimately, the ability to accomplish ADLs.

Participant-friendly, adapted tango had a low attrition rate (14%), demonstrating patient acceptance and feasibility with a diverse patient population [66]. Several mobility programs are effective (e.g., movement strategies, dance, tandem biking, tai chi) for people with PD. A better mechanistic understanding of beneficial exercise effects could improve the design of targeted motor rehabilitation interventions for particular symptoms (e.g., freezing, bradykinesia and various disease stages of PD). This information would be of great clinical significance to individuals with motor impairment of all etiologies, as well as due to PD. Exercise programs for individuals with PD that are self-guided may not be as helpful as programs that involve a therapist or instructor [74]. Gait and balance are increasingly recognized as especially important for determinants of HRQoL, as well as mortality. Tango and other dance forms may improve the axial impairment that greatly affects mobility and, therefore participation and, ultimately, HRQoL in those with PD.

Art therapy
Research on the effects of art therapy in people with PD has primarily been limited to case reports, although more recent work has produced larger efficacy trials. The process of creating art, whether it is through brush stroke or molding of clay, allows patients to express their emotions, leading to an apparent reduction in stress and enhanced relaxed motor state. For example, Elkins-Abhoff et al. [75] observed significant decreases in somatic and emotional symptoms following manipulation of a ball of clay in a large group of patients. Viewing drama and participating in interactive drama projects has also been proposed to improve patients' engagement and a positive sense of self and community. This early evidence suggests that art therapy may also be a complementary treatment modality for patients.

Conclusions
In conclusion, the use of creative arts therapies in the treatment of people with PD shows promise, with initial research showing positive effects. However, there is a substantial lack of research examining the associated

References


Index

AAV2-neurturin, 273, 276
acromegaly, 323
acceptability, rating scales, 232
acccordion-pill endoscopy, 86
acetylcholine deficiency, 142
activities of daily living (ADLs), 124, 199, 351
acupuncture, 353
acute strain/nerve syndrome, 10
ADAGI+ study, 26, 30, 269, 272, 274, 275, 328
ADAS-cog scale, 325, 326, 332
ADCS-CGIC scale, 232, 332
adrenosine A2a antagonists, 86
adrenergic, 86–87
adrenal, 87–88
ADEx-5102, 89
advanced stage PD
COMT inhibitors, 76, 80
DBS, 313–16
levodopa treatment summary, 72–73
adverse effects
anticholinergics, 9–10
apomorphine, 57
bilateral pallidal DBS, 304
bilateral pallidotomy, 303
DBS, 314, 317
dopamine agonists, 41–43
intranasal apomorphine, 59
rasagline, 27
trovaintamine, 336
rotigotine transdermal system, 52
ropinirole, 27
STN DBS, 198, 199–202, 306
subthalamicotomy, 305
surgery, 308
thalatomy-sthalamic DBS, 299
tolcapone, 79
VIM DBS, 211, 212
AE program, 285
aerobic exercise, 349–50
APOQ56, 89–90
agrophobia, 130
AIMS scale, 333
akathisia, 165, 166
akinesia/cortical, 16
akinetic rigid syndromes, 2
ALDS scale, 304, 307
alertness, 152, 218
alpha-blockers, 103
alpha-synuclein, 253–54, 268
Alzheimer’s disease, 76, 111, 117, 125, 128, 141
beta-amyloid and tau proteins, 255
AMP IMPAKT study, 56
amantadine, 13–20, 181
AIDS-5102, 89
compliance behaviour treatment, 17
dyskinesia treatment, 14
ICDAs, 329
levodopa and, 69
amitryptiline, 101
antidepressants for multiple-domain MCI, 122
antidepressant single-domain MCI, 122
amphetamines, 135
amyloid beta, 255, 268
antidepressants, 165, 167
anger, 291
animal models, 270–71
dopaminergic neuroprotection, 318
exercise, 350
lack of, 266
toxin-induced, 271
transgenic, 271
antibodies measures, 293
anticholinergics, 5–10, 132
adverse effects and contraindications, 9–10
current use in PD management, 7–9
future use, 10
levodopa synergies, 9
pharmacokinetics and pharmacodynamics, 6–7
psychosis effects, 141
salolrhea, 101
urinary dysfunction, 102
antidepressants, 27, 104, 117, 150, 133, 167
tricyclic, 103, 133, 327
antidepressants, 89–90
antigluaxonnergics, 13–20
acoustic crisis and neuroleptic malignant syndrome, 16
cognitive improvement, 16
dyskinesia studies, 16
evidence-based results and meta analyses, 14–16
four main effects, 18
ICD and other compulsive disorders, 17–18
psychosis induction, 17
antihypertensives, 104
antisemotics, 4
antipsychotics, 132, 141
anxiety, 128, 129–31, 330
categories, 130
apathy, 128–29, 330
DBS and, 147
definitions, 128
depression and dementia, 129
syndrome, 129
treatment, 129
apomorphine, 55–54, 80, 155
adverse effects, 57
ICDAs, 57
intranasal, 53
long-term therapy effects, 57
motor effects, 54–56
non-motor effects, 56–57
pain relief, 166
pharmacokinetics, 54
sexual dysfunction, 104
surgery, 52
subcutaneous, 100
transdermal patch, 52
supraphotanol, 132, 329
art therapy, 356
aspiration pneumonia, 340
ataxia, limb, 183
atracetine, 124, 326
atropine, 5, 101
attention deficit disorder, 326
attention training, 113
atypical parkinsonian, 66–196, 243, 281
auditory cues, 354
auditory hallucinations, 131
autonomic dysfunction, 93. See also constipation; gastroparesis; orthostatic hypotension; urinary defecatory, 100
drug treatment, 95
sexual, 104–6
thermoregulatory, 106
urinary, 102–4
axial symptoms, anticholinergic effects on
back pain, 166
biperiden, 265
Balanced Index, 300
Beck Depression Inventory (BDI), 291
behavioral disturbances, 127. See also depression; fatigue; impulse control disorders (ICD); psychosis
anxiety, 128, 129–31, 330
apathy, 128–29, 330
deep brain stimulation and, 146–48
drug treatment, 148
personality, 128
treatment-related, 139–40

160
361