

**Vibration Therapy for Parkinson's Disease:  
Charcot's studies revisited**

Sachin S. Kapur, MD<sup>1</sup>, Glenn T. Stebbins, PhD<sup>1</sup>, and Christopher G. Goetz, MD<sup>1</sup>

<sup>1</sup>Department of Neurological Sciences, Rush University, Chicago, IL

Corresponding Author: Christopher G. Goetz, MD

Department of Neurological Sciences, Section of Movement Disorders

1725 W. Harrison St. Ste. 755

Chicago, IL 60612

Phone: 312-563-2900

Fax: 312-563-2024

Email: [cgoetz@rush.edu](mailto:cgoetz@rush.edu)

Word Count: 2768

Abstract: 247 words

References: 24

Tables: 1

Figures: 1

Running Title: Vibration Therapy for PD

Key Words: [165] Parkinson's Disease, [15] Clinical neurology history, Vibration, [20] Clinical trials Randomized Controlled , Charcot

Conflicts of Interest: None

Statement: As the authors, we verify that no ghost writing by anyone not named on the author list has occurred.

Author Roles:

Kapur: Data collection, organization, writing of first draft

Stebbins: Statistical analyses, writing of first draft, review and critique

Goetz: Conception, design, writing of first draft, review and critique

Full Financial Disclosures for the past 12 months:

Dr. Kapur:

Consulting and Advisory Board Membership with honoraria: None

Grants/Research: IIR grant from Pfizer, Inc.

Honoraria: None

Intellectual property Rights: None

Ownership interests: None

Royalties: None

Salary: Rush University Medical Center

Dr. Stebbins:

Editorial Boards: Movement Disorders (past), Journal of Clinical and Experimental Neuropsychology (present)

Consultancies: IMPAX Laboratories, Inc., Ceregene, Inc., Biovail Technologies, LTD, Santhera Pharmaceuticals

Research Support: NIH, Michael J. Fox Foundation for Parkinson's Research, American Cancer Society, Fragile X Foundation

Patents: None

Royalties: None

Dr. Goetz:

Consulting and Advisory Board Membership with honoraria: Addex Pharma SA, Asubio, Biovail Technologies, Cleveland Medical Devices, CNS Therapeutics, Curry Rockefeller Group, Decision Resources, Dixon Group, ICON Clinical Research, Impax Pharmaceuticals, Ingenix, Intec Pharmaceuticals, Kenes International, Medical Education Global Solutions, Ono Pharmaceuticals, Oxford Biomedica, Santhera, United Bioscience Corporation, UCB.

Grants/Research: Funding from NIH, Michael J. Fox Foundation, NIH. Dr. Goetz directs the Rush Parkinson's Disease Research Center that receives support from the Parkinson's Disease Foundation. He directs the translation program for the MDS-UPDRS and UDysRS and receives funds from the MDS for this effort.

Honoraria: Movement Disorder Society, American Academy of Neurology, University of Miami, University of Pennsylvania, University of Montreal. Neurological Society.

Intellectual Property Rights: none

Ownership interests: none

Royalties: Oxford University Press, Elsevier Publishers, Wolters Kluwer Health, Lippincott, Wilkins and Williams.

Salary: Rush University Medical Center

**Background:** The 19<sup>th</sup> century neurologist, J-M Charcot, used a vibration chair for PD based on patient reports of symptom improvements after train or carriage rides. He documented improvement, but after his death (1893), few subsequent studies examined vibration treatment.

**Methods:** Using a specialized lounge chair, we conducted a rater blinded, randomized trial of body vibration vs. no vibration in 20 PD patients. Seated patients wore headphones transmitting music. For those randomized to vibration, a transducer from the sound system induced vibrations through the chair mattress. The primary outcome measure was change from baseline in the motor section of the MDS-UPDRS after daily 30 minute treatments for four weeks. Standardize scales assessed depression, sleep, pain, apathy, anxiety and fatigue. Statistical analyses included descriptive analyses and repeated measures models.

**Results:** Both vibration and no vibration (music) groups significantly improved on MDS-UPDRS Part III after one month of daily treatments. However, there was no significant difference between the two groups. Depression, anxiety, fatigue, and sleep improved in both groups, but the changes were not significantly different between vibration and no vibration treatments. The chair was well-tolerated.

**Conclusions:** Our data confirm Charcot's observation, but suggest that multiple sensory stimuli effect positive changes in PD motor function. Given that studies involving sensory stimulation cannot be double-blind, the effects of study participation and expectation may account for at least some of the observed improvements. The safety profile suggests that patients may try vibration chairs safely with or without the vibration transducer component attached.

**Classification of Evidence:** Class I

## Introduction

In the nineteenth century, decades before dopaminergic therapies were available for treating Parkinson's disease (PD), the celebrated neurologist, Jean-Martin Charcot (1825-1893), treated his patients with vibration therapy. In his lectures, he commented to his students:

I had long been told by patients with paralysis agitans that they derived great relief from prolonged journeys by railroad or carriage. During these travels, the uncomfortable and often painful sensations implicit to this disorder seemed to almost completely disappear, and the benefit persisted for some time after the journey (1) p.150, (2) p.882-883.

To treat patients, he developed a vibration chair (*fauteuil trépidant*) that replicated the continuous jerking of a carriage or train. (Figure 1) He used this therapy for 30 minutes daily to treat his parkinsonian patients on an on-going basis. He reported improvements, but he died shortly thereafter, so that more complete evaluation of the therapy was never completed.

Currently, vibration therapy is used in multiple medical specialties to treat several medical conditions, including orthopedic, urologic, rheumatologic, and sports medicine conditions.(3-6) Specifically in PD, a few studies have examined vibration influences, although their results have been inconsistent.(7-12)

This study evaluated acute and chronic effects of whole body vibration with a focus on objective parkinsonian signs as well as non-motor and overall function. We also assessed patient satisfaction and tolerability.

## Methods

The study was approved by the Rush institutional IRB to study vibration therapy on human subjects. The study design was a randomized, single-blind (rater blinded) comparison of treatment with a vibration chair vs. the same chair without vibration. The vibration apparatus was the SMART (Stress Management and Relaxation Therapy) Lounge (NexNeuro LLC, Schaumburg, IL) vibroacoustic system, marketed as a collapsible lounge chair (Figure 1). Inside the lounge chair mattress, four custom transducers are encased in a 3 inch foam sub-base. During the treatment sessions, patients lay in the recliner chair and wore a set of headphones. All study subjects listened to a CD of nature-based sounds (flowing water, rumblings, animal noises) developed for PD patients by NexNeuro called the Vibration Therapy Parkinson's CD. For those assigned to vibration, the CD player was connected to the mattress transducers utilizing a 150 watt amplifier so that sound waves produced various intensities of vibration throughout the mattress. The frequencies used in the CD ranged from 30 Hz to 500 Hz, scaling across variable amplitudes. (Personal communication, NexNeuro) Following Charcot's description of the high intensity of his vibratory chair, the control for vibration intensity was set at its maximal level. For those assigned to no vibration, the CD player remained disconnected from the transducers so that only the sounds were transmitted through the patients' headphones. The study population had Parkinson Disease (diagnosed by Queen Square Brain Bank criteria) (13) and agreed to stay on the same doses of antiparkinson therapy during the four week daily treatment trial. Patients were Hoehn and Yahr stage I-III, without serious problems with balance, without a history of current falls, and able to rise easily from a chair or bed. Subjects with a history of significant motion sickness or severe hearing problems were not included.

The protocol was designed to examine chronic effects after four weeks of daily treatment, immediate effects of a single session, and patient safety/satisfaction. At baseline, qualifying

subjects underwent the following assessment prior to their assigned, randomized treatment: a self-administered Modified Clinical Global Impression Scale – Severity (CGI), the questionnaire components of Movement Disorders Society version of the Unified Parkinson Disease Rating Scale (MDS-UPDRS), the Fatigue Severity Scale (FSS), the Pittsburgh Sleep Quality Index (PSQI), the Epworth Sleepiness Scale (ESS), the Beck Depression Inventory (BDI), the Beck Anxiety Index (BAI), the Immediate Status Questionnaire (ISQ) assessing immediate pain, mood, anxiety, fatigue, apathy and overall well being in Likert Scale 1-5 format. A rater otherwise not involved in the study and unaware of treatment assignment conducted the motor component of the MDS-UPDRS. To test the acute effects of the intervention, the subject then underwent the first treatment (30 minutes) and afterwards the blinded rater repeated the MDS-UPDRS motor evaluation and the patient completed the ISQ, a satisfaction of treatment analogue scale ranging from 0 (not at all satisfied) to 100 (completely satisfied), and the CGI-C. The chair and accompanying equipment were delivered to the subject's home, and each participant was instructed to undergo the assigned randomized treatment for 30 minutes daily for four weeks. Subjects completed a daily compliance log. After four weeks, the subject returned to the study center to repeat the evaluations done during the first visit including a final 30 minute treatment session at the study center.

The chairs were provided by NexNeuro, but the company had no interaction with the study subjects other than delivering and recuperating the chairs.

The primary outcome measure was the motor (Part III) score of the MDS-UPDRS and the primary outcome for analysis was the change between baseline and final visit after four weeks of daily treatment. MDS-UPDRS change scores immediately after the first and last session were

considered secondary outcomes along with changes in non-motor scales and overall function scales.

Exploratory analyses included the examination of treatment effects (baseline vs. four weeks of treatment and after a single treatment) on the different motor components of PD as measured by Part III of the MDS-UPDRS. Motor components were defined as axial function (speech, facial expression, arising from a chair, gait, freezing of gait, postural stability, posture, global spontaneity of movement), tremor (rest tremor, postural tremor, kinetic tremor), rigidity and extremity bradykinesia (finger tapping, hand movements, pronation/supination, toe tapping, leg agility).

### Statistical Analysis

Baseline descriptive data were analyzed using 2 sample t-test, chi-square or Mann-Whitney U test as appropriate. Analyses of immediate and long-term effects of the treatment condition were analyzed using a repeated-measures analysis of variance (ANOVA) model for parametric data, and a Friedmans's ANOVA with post-hoc comparisons using a Wilcoxon test for non-parametric data. Our sample size of 10 patients per treatment group afforded us sufficient power ( $\geq 0.80$ ) to detect an effect size as small as  $f = 0.574$  with a significance level of  $\alpha = 0.05$  in a repeated measures ANOVA model.

### Results

Twenty six patients expressed interest in the program; one was excluded because she was wheelchair dependent. (Figure 2) One patient tried the chair before signing consent and, finding the vibration to be unpleasantly intense, declined participation, and another was interested but was moving out of the area within the study period. Twenty three subjects were enrolled, and 20

completed. The three subjects who did not complete the program withdrew within the first week, because of discomfort from the vibration (1, assigned to vibration), not having enough room to accommodate the chair at home (1, assigned to vibration) and fear of possible infestation by bedbugs in the mattress (1, assigned to no vibration). Their data were not included in the efficacy analysis and they were replaced to meet the goal of 20 completed subjects.

Baseline and randomization: The mean age of the 20 completed subjects (14 men, 6 women) was 64.3 (SD 8.35), and the mean duration of PD was 6.05 years (SD 3.64). All patients were either Hoehn and Yahr stages 2 (13 subjects) or 3 (7 subjects). Mean baseline motor MDS-UPDRS was 38.15 (SD 9.20) and the median CGI score was 3 (range 2 – 5). Twelve of the subjects were taking carbidopa/levodopa; 6 subjects were on a MAO-B inhibitor, a dopamine agonist, or amantadine; and 2 subjects were not taking any PD medications.

10 subjects were randomized to vibration and 10 to no vibration. The MDS-UPDRS motor scores were not significantly different in the two groups at baseline (40.2 (SD 8.67) for the no vibration group vs. 36.1 (SD 9.53) for the vibration group;  $p = 0.33$ ). Additionally, there were no other significant differences in baseline scores for all assessments between the two treatment groups (all  $p$ 's  $> 0.22$ ).

Compliance: The compliance log was returned by 18/20 subjects whose compliance was 93.5%. The two subjects who did not return compliance diaries reported 100% compliance.

Primary outcome measure for chronic treatment (Table): There was a significant improvement in MDS-UPDRS Part III (Motor scale) score for both the vibration and the no vibration treatment groups following daily 30-minute treatments for four weeks ( $F[1,18] = 13.78$ ,  $p = 0.002$ ). The mean improvement in the group without vibration was 3.6 points, (SD 4.03) and the mean

improvement in the vibration group was 5.50 points (SD 6.62). Although the mean incremental improvement was higher for the vibration group, the difference between vibration and no vibration groups was not significant ( $F[1,18] = 0.60, p = 0.45$ ).

The exploratory analysis examining treatment effects on the different motor components of the MDS-UPDRS items (tremor, extremity bradykinesia, rigidity, and axial involvement) revealed a significant improvement in bradykinesia following chronic treatment ( $F[1,18] = 8.97, p = 0.008$ ). However, there was no significant difference between the vibration and no vibration conditions ( $F[1,18] = 1.19, p = 0.29$ ). There were no significant treatment effects on the other components of the MDS-UPDRS with either treatment.

Secondary outcome measures for chronic treatment (Table): There were significant improvements in MDS-UPDRS Part 1 (Non-motor Aspects of Experiences of Daily Living), depression (BDI), anxiety (BAI and ISQ anxiety), fatigue (FSS) and nighttime sleep (PSQI) (all  $p$ 's  $< 0.04$ ) for both treatment groups following daily 30-minute treatments for four weeks. Differences between the treatment groups on these measures, however, were not significant. There were no significant changes over time on MDS-UPDRS Part II (Patient Questionnaire on motor experiences of daily living), MDS-UPDRS Part IV (Motor Complications), CGI-C scores, daytime sleepiness (ESS) or ISQ measures of pain, mood, fatigue, apathy or overall well being (all  $p$ 's  $> 0.11$ ).

Outcome measures for acute treatment: There was no significant change in MDS-UPDRS Part III score following acute treatment for either treatment group. There were significant treatment related improvements in the ISQ scores assessing immediate changes in pain, anxiety, fatigue

and overall well being following acute treatment (all  $p$ 's  $< 0.01$ ), but there were no significant differences between the treatment groups.

Satisfaction and tolerability: The treatment intervention was well tolerated among the subjects who completed the trial. One patient experienced mild back discomfort that improved following adjustment to the chair. The mean patient satisfaction score was 77.11 (SD 21.71) for the vibration group and 79.78 (SD 22.08) for the no vibration group (scale range from 0 (not at all satisfied) to 100 (completely satisfied) and there was no difference in satisfaction between the two treatment groups ( $p = 0.799$ ).

## Discussion

We confirmed Charcot's observation of improvement in PD symptomatology with chronic vibration treatment, but we did not find the effect to be specific to vibration. Instead, our data suggest that multiple sensory stimuli have the potential to alter motor function. Because studies involving sensory stimulation cannot be double-blind, the effects of study participation and expectation may account for at least part of the improvements we observed. Charcot commented specifically on the immediate effects on pain and discomfort, and our study confirmed that pain and fatigue scores significantly improved with single treatments. Again, however, we did not find the effects to be specific to vibration, as scores in these domains improved equally in those assigned to the no vibration group that received music stimulation only.

Our sample size of 10 patients per treatment group afforded us ample power to detect an effect size as small as  $f = 0.574$  on the repeated measures ANOVA model. We did not anticipate, however, a marked improvement in our control group, especially in the context of an unblinded study. Although we found a greater UPDRS motor improvement in the vibration group, the

mean 2 point difference from the non-vibration group represented an actual effect size of only  $f = 0.032$ , well below the threshold for detection of significance with our sample size. To explore the possibility that the observed difference would have been statistically significant with a higher sample size, we calculated the required sample size to detect an effect as small as  $f = 0.032$ . The total number of subjects required to detect such a small effect size would have been 5,752 total subjects, half assigned to vibration and the other half assigned to no vibration. Such a large required sample size suggests that the differential effect of vibration over no vibration is in fact quite modest and supports our finding of no specific treatment effect due to vibration alone.

Prior studies of vibration therapy for medical uses have focused on orthopedics, rheumatology, sports medicine, and geriatrics. (3, 5, 6, 14, 15) In neurology, specifically, studies have focused on multiple sclerosis (16, 17) and PD (7-12). The studies for PD have used variable methodology (duration of treatment, length of trial, primary endpoints) and variable equipment with inconsistent results. Most of the studies utilized a vibration platform on which subjects stand, and only one utilized a chair similar to ours.(16) Control or comparison groups utilized in these other studies included no specific intervention, a comparable period of rest, conventional balance training, or moderate walking. Most evaluated the impact of a single session of vibration (usually 15 minutes) and only two (7, 11) evaluated the effects of vibration over multiple sessions (3-5 weeks). Two studies (13, 16) reported that a single session of the whole body vibration significantly reduced tremor and rigidity as measured by the UPDRS. In the chronic treatment protocols, no significant improvement in UPDRS scores compared to the comparison groups could be documented.(7, 11) A 2011 systematic review of these studies concluded that there was still insufficient evidence to establish vibration as an effective therapy for PD (8).

Our study is different from the past studies in that it offers a prospective, randomized, and rater-blinded study with acute and chronic treatment assessments. We attempted to mimic Charcot's protocol with modern equipment in order to confirm or refute a historical observation (18).

Ours is the only study that has used a 30 minute period of treatment every day for four weeks as the tested intervention. The apparatus allowed us to develop a comparator treatment of music relaxation with no vibration, because all patients listened to the headphone music. Those having the sound transducer connection received the sound-generated vibrations, and the comparator group had the same chair and music, but without vibration. In our view, this protocol is more rigorous than the prior reports and is historically anchored in a world-renown neurologist's open label pilot observations.

Very little is known about the impact of vibration on the physiological function of the basal gangliar circuits. As an empiricist who did not pursue physiological mechanisms underlying neurological disorders, Charcot simply concluded that "vibration is acting as a powerful sedative force on the nervous system."(1)(p. 151)(2)(p.884). Others have speculated that vibratory stimuli may affect dopaminergic function, with one study showing that whole body vibration and noise increase dopamine turnover in the frontal lobe and nucleus accumbens of rats.(19) Another theory has focused attention on mobilization of basal gangliar motor control function through enhanced peripheral proprioceptive stimulation.(20) In our view, given that the group receiving only music stimulation without vibration improved similarly to the vibration group, non-specific effects related to sensory stimulation of different types is a more likely explanation, and both auditory and visual cueing has long been demonstrated to improve gait freezing in PD patients.(21, 22) We do not think that the outcome relates to relaxation effects, shown in other studies to improve PD motor and quality of life measures (23, 24), because the study subjects

and the investigators themselves considered the intensity of the vibrations, their changing frequencies and unpredictable distribution within the mattress to be highly stimulating, keeping the subjects alert and attentively focused during the treatments.

The strengths of our study include the randomized controlled design, the high compliance of our study subjects, and the blinded rater assessment. Limitations of our study include the potential that environmental factors surrounding the sessions at home (room choice, timing relative to individual schedules) were variable among the subjects. As a commercially available device, the vibration apparatus had certain control buttons for adjustment of the level of vibration that we could not set permanently, so that it is possible that patients inadvertently or purposefully adjusted the vibration intensity during the treatment phase in spite of our instructions to leave it at its maximal setting.

The safety profile of the tested apparatus and treatment suggests that patients may try vibration chairs with or without the vibration component attached in confidence that they will not experience serious adverse events. Even in an era with many more therapeutic options than at the time of Charcot, his advice to colleagues resonates as one places vibration therapy in the context of potential options for patients “It is no small gain to be able to relieve the sufferers of paralysis agitans.(1)(p.150),(2) (p.883-4).

## References

1. Charcot J. La médecine vibratoire: application des vibrations rapides et continues a traitement de quelques maladies du système nerveux. *Prog Méd* 1892;149-151.
2. Charcot J. Vibratory therapeutics: the application of rapid and continuous vibrations to the treatment of certain diseases of the nervous system. *The Journal of Nervous and Mental Disease* 1892;880-886.
3. Prisby RD, Lafage-Proust M-H, Malaval L, Belli A, Vico L. Effects of whole body vibration on the skeleton and other organ systems in man and animal models: What we know and what we need to know. *Ageing Research Reviews* 2008;7:319.
4. Alaca R, Goktepe AS, Yildiz N, Yilmaz B, Gunduz S. Effect of Penile Vibratory Stimulation on Spasticity in Men with Spinal Cord Injury. *American Journal of Physical Medicine & Rehabilitation* 2005;84:875-879.
5. Sañudo B dHM, Carrasco L, McVeigh JG, Corral J, Cabeza R, Rodríguez C, Oliva A. The effect of 6-week exercise programme and whole body vibration on strength and quality of life in women with fibromyalgia: a randomised study. *Clinical and Experimental Rheumatology* 2010;28:S40-45.
6. VB I. Vibrations and their applications in sport. A review. *Journal of Sports Medicine and Physical Fitness* 2005;45:324-336.
7. Arias P, Chouza M, Vivas J, Cudeiro J. Effect of whole body vibration in Parkinson's disease: A controlled study. *Movement Disorders* 2009;24:891-898.
8. Lau RWK, Teo T, Yu F, Chung RCK, Pang MYC. Effects of Whole-Body Vibration on Sensorimotor Performance in People With Parkinson Disease: A Systematic Review. *Physical Therapy* 2011;91:198-209.
9. Haas TH, Turbanski S, Kessler K, Schmidtbleicher D. The effects of random whole-body-vibration on motor symptoms in Parkinson's disease. *NeuroRehabilitation* 2006;29-36a.
10. Chouza M, Arias P, Viñas S, Cudeiro J. Acute effects of whole-body vibration at 3, 6, and 9 hz on balance and gait in patients with Parkinson's disease. *Movement Disorders* 2011;26:920-921.
11. Ebersbach G, Edler D, Kaufhold O, Wissel J. Whole Body Vibration Versus Conventional Physiotherapy to Improve Balance and Gait in Parkinson's Disease. *Archives of Physical Medicine and Rehabilitation* 2008;89:399-403.
12. King L, Almeida, QJ, Ahonen, H. Short-term effects of vibration therapy on motor impairments in Parkinson's Disease. *NeuroRehabilitation* 2009;25:297-306.
13. Hughes AJ, Daniel SE, Kilford L, Lees AJ. Accuracy of clinical diagnosis of idiopathic Parkinson's disease: a clinico-pathological study of 100 cases. *Journal of Neurology, Neurosurgery & Psychiatry* 1992;55:181-184.
14. Merriman H JK. The effects of whole-body vibration training in aging adults: a systematic review. *Journal of Geriatric Physical Therapy* 2009;32:134-145.
15. Bogaerts ACG, Delecluse C, Claessens AL, Troosters T, Boonen S, Verschueren SMP. Effects of whole body vibration training on cardiorespiratory fitness and muscle strength in older individuals (a 1-year randomised controlled trial). *Age and Ageing* 2009;38:448-454.
16. Schyns F, Paul L, Finlay K, Ferguson C, Noble E. Vibration therapy in multiple sclerosis: a pilot study exploring its effects on tone, muscle force, sensation and functional performance. *Clinical Rehabilitation* 2009;23:771-781.
17. Wunderer K, Schabrun SM, Chipchase LS. Effects of whole body vibration on strength and functional mobility in multiple sclerosis. *Physiotherapy Theory and Practice*;26:374-384.

18. Goetz CG. Jean-Martin Charcot and his vibratory chair for Parkinson disease. *Neurology* 2009;73:475-478.
19. Nakamura H, Moroji T, Nohara S, Nakamura H, Okada A. Activation of cerebral dopaminergic systems by noise and whole-body vibration. *Environmental Research* 1992;57:10-18.
20. Rivlin-Etzion M, Marmor O, Heimer G, Raz A, Nini A, Bergman H. Basal ganglia oscillations and pathophysiology of movement disorders. *Current Opinion in Neurobiology* 2006;16:629-637.
21. Azulay J-P, Mesure S, Blin O. Influence of visual cues on gait in Parkinson's disease: Contribution to attention or sensory dependence? *Journal of the Neurological Sciences* 2006;248:192-195.
22. Rochester L, Burn DJ, Woods G, Godwin J, Nieuwboer A. Does auditory rhythmical cueing improve gait in people with Parkinson's disease and cognitive impairment? A Feasibility study. *Movement Disorders* 2009;24:839-845.
23. Schlesinger I, Benyakov O, Erikh I, Suraiya S, Schiller Y. Parkinson's disease tremor is diminished with relaxation guided imagery. *Movement Disorders* 2009;24:2059-2062.
24. Brefel-Courbon C, Desboeuf K, Thalamas C, et al. Clinical and economic analysis of spa therapy in Parkinson's disease. *Movement Disorders* 2003;18:578-584.

Figure 1: Vibration chairs



Figure legend: Vibratory chair (fauteuil trépidant) constructed under the direction of Charcot in the nineteenth century (left) and the Vibration chair (NexNeuro) utilized in this program with headphones, CD player, and amplifier(right).

Figure 2. Flow Diagram

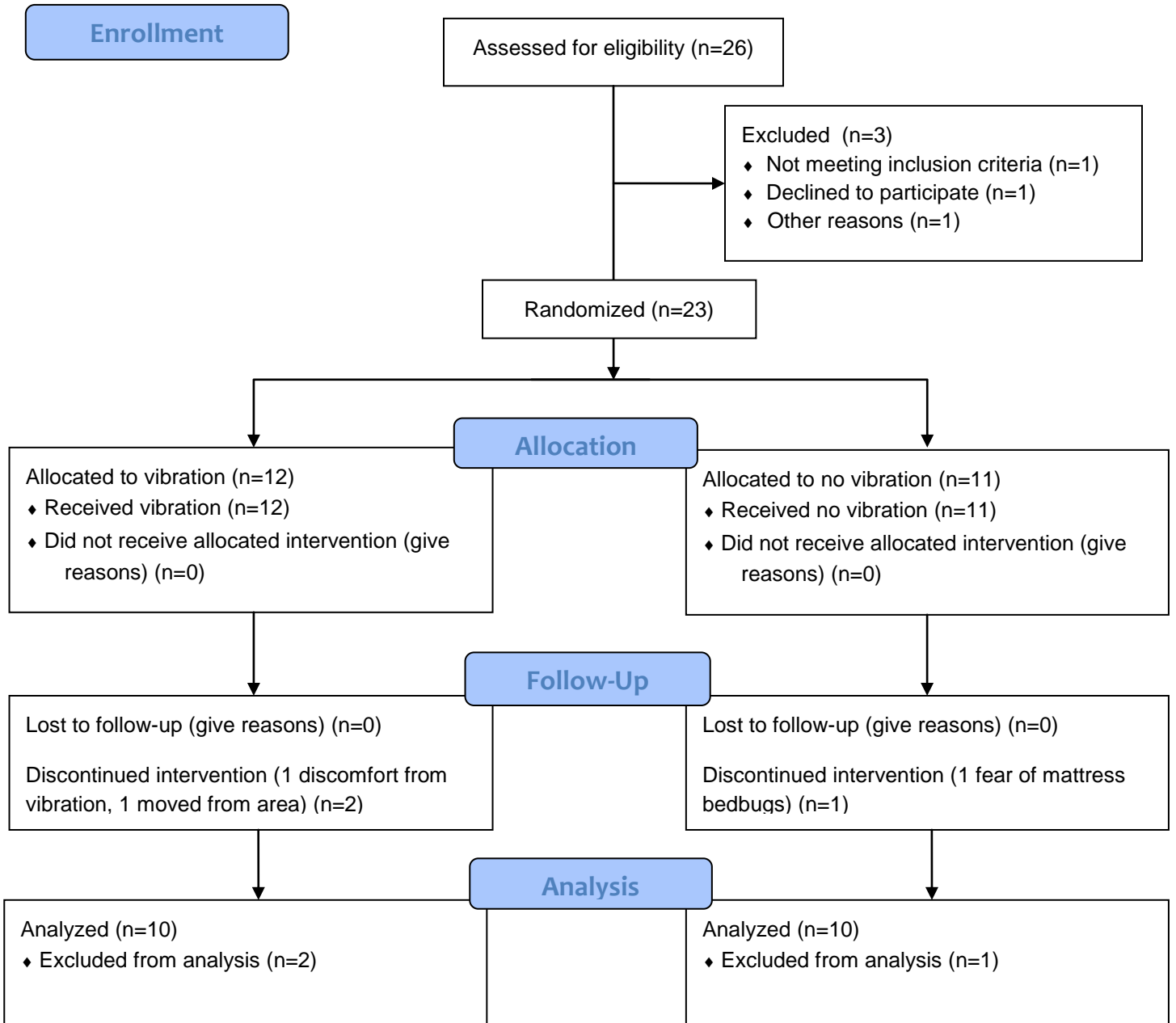


Table 1. Summary of acute and chronic treatment effects on primary and secondary outcomes.

	<b>Baseline total</b>	<b>Post tx total chronic</b>	<b>P values (time effects)</b>	<b>Baseline (vibration)</b>	<b>Post tx (vibration)</b>	<b>Baseline (no vib.)</b>	<b>Post tx (no vib.)</b>	<b>P values (tx effects)</b>
MDS-UPDRS Part I	8.75 (4.92)	6.45 (2.60)	0.032	7.60 (3.31)	6.00 (1.94)	9.90 (6.05)	6.90 (3.32)	0.291
MDS-UPDRS Part II	10.05 (4.31)	8.95 (3.99)	0.100	9.10 (4.46)	8.20 (3.80)	11.00 (4.42)	9.70 (4.24)	0.354
MDS-UPDRS Part III	38.15 (9.20)	33.60 (8.81)	0.002	36.10 (9.53)	30.60 (9.30)	40.20 (8.87)	36.60 (7.58)	0.196
MDS-UPDRS Part IV	2.20 (3.86)	1.85 (3.11)	0.501	1.90 (3.84)	1.30 (2.75)	2.50 (4.06)	2.40 (3.50)	0.582
PSQI	7.80 (3.81)	6.45 (3.40)	0.040	7.50 (4.25)	6.30 (4.00)	8.10 (3.51)	6.60 (2.88)	0.733
FSS	29.21 (11.73)	24.84 (11.98)	0.037	29.89 (9.17)	26.00 (12.28)	28.60 (14.12)	23.80 (12.27)	0.816
ESS	8.25 (5.53)	6.35 (3.76)	0.069	9.00 (5.62)	6.70 (3.53)	7.50 (5.64)	6.00 (94.14)	0.574
BDI	7.05 (4.63)	5.10 (3.11)	0.012	6.70 (4.60)	5.20 (3.88)	7.40 (4.88)	5.00 (2.31)	0.882
BAI	6.75 (6.29)	4.35 (3.92)	0.033	5.00 (2.16)	3.50 (2.12)	8.50 (8.49)	5.20 (5.14)	0.226
CGI	3.60 (0.75)	3.35 (0.75)	0.062	3.50 (0.97)	3.30 (0.82)	3.70 (0.48)	3.40 (0.70)	0.643
ISQ- Pain	0.80 (0.83)	0.70 (0.66)	0.535	0.90 (0.99)	0.60 (0.70)	0.70 (0.68)	0.80 (0.63)	1.00
ISQ- Apathy	0.55 (0.95)	0.80 (1.10)	0.105	0.70 (1.06)	1.00 (1.15)	0.40 (0.84)	0.60 (1.07)	0.438
ISQ- Mood	0.85 (0.99)	0.85 (0.81)	1.00	0.60 (0.97)	0.90 (0.99)	1.10 (0.99)	0.80 (0.63)	0.596
ISQ- Fatigue	1.55 (1.32)	1.40 (0.94)	0.492	1.40 (1.51)	1.30 (1.25)	1.70 (1.16)	1.50 (0.53)	0.606
ISQ- Anxiety	0.95 (1.10)	0.60 (0.75)	0.018	0.80 (1.03)	0.50 (0.53)	1.10 (1.20)	0.70 (0.95)	0.548
ISQ- Overall Well Being	1.00 (0.92)	1.05 (0.76)	0.716	0.80 (0.92)	1.00 (0.82)	1.20 (0.92)	1.10 (0.74)	0.492
Satisfaction					77.11 (21.71)		79.78 (22.08)	0.799

