Effectiveness and Implementation of the HiBalance Program in Clinical Practice

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Improving balance and physical activity in elderly with Parkinson's disease –effectiveness in a clinical practice of the HiBalance program

This study is a part of the larger BETA (Balance, Elderly, Training and Activity) study that consists of two parts: Osteoporosis and Parkinson's disease (PD). The long-term goal of the larger BETA study is to reduce the risk of falls in elderly. We predict that increased balance control following training will lead to greater confidence in everyday life, increased levels of physical activity and an improved health related quality of life. The goal is also to establish evidence-based rehabilitation programs for balance and gait function and to further develop and implement an educational curriculum where health care professionals can learn to manage such programs for elderly nationwide.

The BETA-PD study of which Erika Franzén is the PI of consists of several parts: method development and laboratory studies, efficacy study and an effectiveness/ implementation study. Here we are applying for the effectiveness and implementation part.

The BETA-PD project aims to translate basic neuroscience into applied research and clinical understanding and implement the evaluation methods and training program into clinical practice. We hypothesize that increased balance control following training will lead to greater confidence in everyday life, increased levels of physical activity and an improved health related quality of life. The addition of physical activity on prescription will further improve the health benefits of this program in the long-term follow-up. With this new concept of balance training, our outcome measurements and educational curriculum, we foresee a paradigm shift in how balance training is applied and evaluated in clinical practice for elderly with balance deficits.

BACKGROUND

Falls are a major cause of ill-health and may lead to functional impairment, disability, a lower quality of life and fractures among elderly (Kannus, Uusi-Rasi et al. 2005, Madureira, Takayama et al. 2007). Injurious falls and fear of falling are especially common in elderly with Parkinson's disease (PD) (Bloem, Grimbergen et al. 2001). The most is Parkinson's disease (PD). Parkinson's disease is the most common neurodegenerative disorder next to Alzheimer's disease leading to a loss of dopamine producing cells in the basal ganglia and is mainly present around the age of 60 to 85 years of age. The basal ganglia are among the most important central structures for the control of posture and movement. The primary symptoms of PD are tremor, rigidity, bradykinesia and impaired postural stability (balance control) (Nutt, Hammerstad et al. 1992). Many of these symptoms affect balance and walking abilities in everyday tasks (Nutt, Hammerstad et al. 1992, Franzen, Paquette et al. 2009). Postural instability is not just one of the most disabling symptoms of PD it is also one factor that increase the risk of falling, which occurs in 38-68% of the people with PD (Balash, Peretz et al. 2005). Furthermore, elderly with PD have shown reduced levels of physical activity (Fertl, Doppelbauer et al. 1993) and a nine times increased risk of injurious falls, compared with the healthy elderly (Bloem, Grimbergen et al. 2001). Balance and walking impairments are present even in the early stages of PD (Carpinella, Crenna et al. 2007) and have been shown to be associated with restrictions in everyday activities (Tan, McGinley et al. 2011) and reduced quality of life (Ellis, Cavanaugh et al. 2011).

Balance problems may lead to physical inactivity, which in turn leads to increased unsteadiness and a vicious cycle with less mobility, muscle weakness, falls and fractures (King and Horak 2009). Physical activity is today considered a highly potent prevention of and treatment for a large number of conditions and diseases (PAGAC 2008, Ståhle 2010). Approximately 60% of the adult population in the world today does not meet the physical activity recommendations, (Balash, Peretz et al.). However, the level of physical activity in elderly with PD remains unclear. Accelerometer data from

our study show that only 27% of the individuals with mild to moderate Parkinson's disease meet the recommendations of physical activity (Wallén, Franzén et al. Submitted 2014).

Balance control relies on the interaction of several physiological systems (musculoskeletal, neuromuscular, cognitive and sensory systems) with environmental factors and the performed task (Horak F 1996). However, as degeneration of the basal ganglia affects many physiological systems essential for balance control, balance disorders in PD cannot be addressed to one single function but, rather, are the result of impairments of multiple systems such as impaired sensory integration, poorly timed an scaled anticipatory postural adjustments, reduced reactive control and motor coordination as well as decreased stability limits (Franzen, Paquette et al. 2009, King and Horak 2009). Another critical aspect of balance control in PD is the ability to divide attention and simultaneously process multiple tasks (motor or cognitive), i.e. multi-tasking. While performing a dual- or a multi-task activity, individuals with PD compared with healthy subjects are more inclined to shift attention away from the balance task, which can lead to falls (Bloem, Grimbergen et al. 2006).

As PD progresses, balance problems gradually increase and are generally non-responsive to or worsen with levodopa treatment (Horak F 1996, Franzen, Paquette et al. 2009, Wright, Gurfinkel et al. 2010). Currently, there is a growing body of research that highlights the role of physical exercise as an essential part of managing the disease, with potential neuroprotective mechanisms (Hirsch and Farley 2009, Ahlskog 2011, Petzinger, Fisher et al. 2013). Furthermore, exciting new findings in neuroscience regarding the effects of exercise on neural plasticity and neuroprotection of the brain against neural degeneration suggests that exercise can improve brain function in patients with neurological disorders (King and Horak 2009, Petzinger, Fisher et al. 2013). Moreover, the effects of balance training on balance and gait performance are promising for individuals with PD (Dibble, Addison et al. 2009, Allen, Sherrington et al. 2011), although several questions remain unanswered, particularly regarding dose, intensity and duration, as well as regarding specific exercises to improve balance control in the different stages of the disease (Kwakkel, de Goede et al. 2007, Goodwin, Richards et al. 2008, Allen, Sherrington et al. 2011). The training stimuli used in previous training interventions have been criticized for not being challenging or intensive enough (Allen, Sherrington et al. 2011). Furthermore, it is unclear whether specific training effects on balance can be generalized to restrictions in everyday living or enhance physical activity level in PD, especially in a long-term perspective (Lees, Hardy et al. 2009).

We have therefore designed a program that emphasizes highly challenging aspects of balance control, the HiBalance program, based on a translational approach, incorporating knowledge from basic science, motor learning, and clinical practice (Conradsson, Löfgren et al. 2012). To address PD-specific balance impairments, this program was developed by linking PD symptoms to core areas of balance control and was subsequently translated into principles of training (Conradsson, Löfgren et al. 2012, Conradsson, Löfgren et al. 2013). Together with physical activity on prescription, we found the program to significantly improve balance performance, gait velocity, step length and dual-tasking ability. In addition, favorable transfer effects were seen in relation to physical activity levels as well as to performance in activities of daily living (Conradsson, Lofgren et al. 2015).

Preliminary results of the short-term effects show that this program is not only improving balance and gait ability in elderly with mild to moderate PD but also has beneficial effects to everyday living seen as improved physical activity level and activities of daily living.

In the literature there are many studies reporting on the efficacy of certain treatments, methods or training programs, which often may take years for the researchers to develop. Few of the researchers take their results further into clinical practice and, if so, it may take years for them to come into daily use (Nilsen 2010). This delay means that possible health gains are not achieved as quickly as one would have hoped for (Guldbrandsson 2007), i.e. there is a large gap between what is known and

what is consistently done (Bhattacharyya, Estey et al. 2011). It is, therefore, of great importance that programs proven to have beneficial impact on health and health related quality of life in a clinical trial setting, are being implemented as soon as possible into clinical practice. Furthermore, it is of importance to identify relevant facilitators and barriers for implementation, in order to develop effective implementaion strategies. Intervention fidelity describes the extent to which an intervention is carried out as it was intended (Fraser 2009). Knowing if an intervention was carried out as planned it is essential to understand which factors that contributed to an effect. To be able to study fidelity it is important to define the core components of an intervention.

Hence, we are now planning an effectiveness study, during which we will test the effectiveness of the HiBalance program in clinical settings such as primary geriatric care and neurorehabilitation centres while simultaniously gathering information on barriers and facilitators (hybrid design). This will provide information on the effectiveness of the program, but also on which factors influence the implementation of the program in practice. This information can in turn be used to develop implementation strategies that support the implementation of the program into rutine clinical practice.

OBJECTIVES

The specific aims related to Step 3:

1. Describe the utilization and satisfaction regarding balance training and physiotherapy in individuals with PD as well as the treatment characteristics and knowledge regarding PD among physiotherapists in Sweden (surveys).

2. Evaluate the effectiveness of the balance training program regarding gait, balance function, physical activity levels and health related quality of life in clinical settings (case-control study).
3. Conduct a process-evaluation and identify relevant facilitators and barriers for implementation the program into clinical practice (effectiveness-implementation hybrid design).
4. Develop and test educational material for dissemination of the intervention to physioterapists working with PD and to promote exercise for people with PD

CONNECTION TO PREVIOUS PROJECTS / PRELIMINARY RESULTS

During the first years (2011-2013) of the project we have tested the validity and reliability of the measurement methods that we use. For example, we have translated, culturally adapted and tested the validity of the new clinical balance test called, Mini-BEST test, for use in patients with PD. We are now in the process of evaluating its feasibility and reliability. Preliminary results shows high concurrent validity, inter- (ICC= 0.775, SEM= 1.78) as well as test-retest reliability (ICC=0.895, SEM = 1.22) in this group of mild to moderate PD. To be able to analyze physical activity measured with accelerometers, methodology studies in PD are also required. We have therefore compared common free-living physical activity parameters assessed with accelerometers and processed with two different filter settings as well as conducted a calibration study in a sample of elderly individuals with PD (Nero et al., accepted Plos One). Furthermore, we have compared self-reported pedometer steps with accelerometer steps in patients with PD and shown that the steps were found to agree poorly with accelerometer steps (Wallen, Dohrn et al. 2013).

We have also conducted a kinematic study in a movement laboratory in which we have investigated turning strategies as well as the effect of levodopa on these strategies in 20 with individuals with PD (ON and OFF their medication) and 20 healthy controls. Preliminary results show an improvement in turning performance due to ant-parkinson medication however no effects on axial coordination (manuscript in preparation).

We have during 2011 developed this intervention related to PD symptoms (Conradsson, Löfgren et al. 2012) and conducted a pilot study with subjects with PD and showed the training program to be feasible (safety, intervention compliance, pain and general fatigue) and exercise progression was easily performed during training (Conradsson, Löfgren et al. 2013). Thereafter (2012- ongoing), 100 elderly with PD (Hoehn & Yahr 2-3) were assessed and randomized to a training group (n=51) with 10-week (3 times/week) of highly balance exercises, or to a control group (n=49) that carried on with their normal life-style activities. Results of the short-term effects show that the training group, compared to the control group, significantly improved in domains specifically targeted in this intervention: balance performance, gait velocity, step length, cognitive performance while dual-tasking, as well as beneficial transfer effects to everyday living, seen as increased physical activity level and improved activities of daily living. No significant group differences were found for fear of falling and health related quality of life (submitted mamnuscript). Long-term follow-up assessments will further explore these effects.

We have also conducted a qualitative study to describe perceptions, experiences and beliefs of balance and physical activity in the daily life after participating in our balance intervention by means of semi-structured interviews with open-ended questions. We have interviewed 13 individuals with PD, which have been transcribed and are under analysis. Preliminary data show that they have a good coping strategy to keep their balance and avoid falls. Moreover, they express that physical activity and training is beneficial for them although they see limitations in keeping active such as the progression of the disease, aging and also a limited range of training opportunities.

STUDY DESIGN, METHODS AND WORKPLAN

We use a wide range of novel methodologies in the BETA-PD study, from laboratory (motion analysis and force plates), to semi-laboratory (pressure sensitive gait analysis mat and accelerometers) to clinical measures (Mini-BESTest, one-leg stance, disease rating scales) as well as questionnaires (fear of falling and health related quality of life) and qualitative approaches (interviews and focus groups).

The **HiBalance program** is based on scientifically well-established principles of exercise training and postural control as well as current research on training in PD (Franzen, Paquette et al. 2009, Allen, Sherrington et al. 2011, Petzinger, Fisher et al. 2013). The program is based on the current knowledge of the neurophysiology and the inevitable constraints on mobility and postural control resulting from basal ganglia degeneration. The training was conducted as a progressive individually adjusted group program, led by experienced physiotherapists and researchers in order to challenge the specific balance disorder of every participant and endorse progression. In this training program, four main subsystems underlying balance control (stability limits, anticipatory postural adjustments, sensory integration, motor agility) are used to target symptom specific balance impairments, see Figure 4. Intermittent presence of reactive postural adjustments is used as an indicator of the relevant level of difficulty. This 10-week intervention is performed three times/week in groups of six to seven participants and is divided into three phases where movement complexity in combination with multitasking is increased. To ensure highly challenging exercises, each task is individually adapted e.g. by changing area of base of support, increasing movement speed/amplitude, restricting vision and varying the grade of multitasking.

After the last training session, a meeting will take place, where the participants will take part in a group discussion, led by physiotherapists, on how to sustain or increase their level of physical activity.

Here we are descibing the effectiveness and implementation of the program into clinical practise.

EFFECTIVENESS AND IMPLEMENTATION IN CLINICAL SETTINGS

This part consists of a clinical effectiveness trial together with implementation research. We are here planning to use a hybrid design, testing effects of the HiBalance training program delivered in clinical setting on relevant patient outcome measure while observing and gathering information on the implementation process, including barriers and facilitators (Curran, Bauer et al. 2012). This approach can provide more rapid translational gains, more effective implementation strategies and more useful information for decision makers than pursuing effectiveness trials and implementation research independently.

Since the HiBalance program has shown beneficial effects in a controlled hospital setting, we foresee an immediate need to test the effectiveness of the program under less controlled conditions (Fraser 2009) i.e., in other settings, such as primary and elderly care settings and delivered by Physiotherapists in these clinics. By use of a hybrid design, we will be able to collect information on effectiveness on patient level, whether the program was implemented as intended by conducting a process evaluation and which factors might have influenced the implementation (Curran, Bauer et al. 2012). The collected information on barriers and facilitators will serve as the foundation for development of implementation strategies and educational material.

Survey

Initially a survey among individuals with PD will be performed to describe the utilization and patient satisfaction of balance training and physiotherapy treatments. In addition, a survey among physiotherapists will describe treatment characteristics, knowledge and skills with regards to PD. Despite several efficacy studies on exercise and physiotherapy in PD, only limited data regarding the utilization and patient satisfaction of physiotherapy by patients with PD are available (Keus, Bloem et al. 2004). There is also limited information about knowledge / skills and self-efficacy regarding training and treatments among physiotherapists as well as the nature of the treatments given by physiotherapists. Better insight into the quantity (e. g. referral rates and treatment duration) and quality (e. g. contents of treatment, therapist expertise and patient satisfaction) of physiotherapy in PD is therefore needed before an efficacy study can be performed in clinical settings. Web-based questionnaires will therefore be sent out to physiotherapists and individuals with PD living in Sweden. Recruitment will be made through the member directory of the Swedish Parkinson association (survey for people with Parkinson's disease) and the Swedish physiotherapist association (survey for physiotherapists). For feasibility purposes, the questionnaires will be piloted among 10 patients and 10 physiotherapists before the final version of the questionnaires will be drawn up. The questionnaire to patients will consist of items regarding socio-demographic status, diagnosis, activities of daily living, utilization of and satisfaction with physiotherapy treatment. In the questionnaire to physiotherapists they will be asked about general therapist and treatment characteristics (e. g. working experience and interest in PD) and specific treatment characteristics such as treatment goals, intensity and duration. *(The questionnaire for physiotherapists has ethical approval see Dnr:2015/570-32)*

Effectiveness

This effectiveness study will be based on the knowledge gained based on the survey and are planned to comprise four to six different clinical settings such as primary care facilities and neurorehabilitation centres. We have already established contacts with primary care and rehabilitation facilities in Stockholm (Stockholms sjukhem, Karolinska universitetssjukhuset, Bromma geriatriken, Stora Sköndal). The academic primary care facilities (Akademiska vårdcentralerna) in Stockholm will also be an interesting partner in the implementation. We expect clinics to join the study in a sequence and are here starting with Stockholms sjukhem, Karolinska universitetssjukhuset and Stora Sköndal. One hundred participants will be recruited through the participating clinics.

100 participants will be recruited from the participating clinics. 50 patients will act as a training group and 50 as a control group. The control group will consist of patients waiting to participate in a training group and will be offered training after a control period of 10 weeks.

The 10-week balance training program (HiBalance) will be performed two or three times per week for one hour each. A pilotstudy will compare the feasibility, the progression using accelerometers during the session as well as explore barriers and facilitators for performing the traning two or three times/week (ethical approval for the pilot Dnr:2015/570-32). The training will be lead by physiotherapists in the clinics. Patient level outcome variables will be adapted to the clinical environment and will be balance performance (Mini-BESTest), gait ability (10 meter walk-test and Timed Up and Go with and without concomitant cognitive and motor tasks), physical activity level and intensity (accelerometers/pedometers), health related quality of life (EQ5D). The tests will be performed by the physiotherapists in the clinic and conducted before and after the training period. As a part of the implementation, we will choose measurements developed and tested in clinical practice.

To evaluate the effectiveness of the HiBalance program in clinical settings mixed models will be used. Sample size is based on the key outcome variable (Mini-BESTest) and based on data from the pilot study of the effectiveness study. With a 80% power andan alfa level of 0.05, a minimum of 37 subjects in each group will be required dectect a change of 1 point between groups. The dropout rate was set at 15%, Taken together, to ensure adequate statistical power the sample size for this study would optimally be 50 per group (total
n = 80).

Implementation
A participatory approach will be used for implementation of the HiBalance program, where the clinics and physiotherapist will be engaged in an early face (Scheirer, Hartling et al. 2008). The strategies for implementation will include: 1) meetings with the head of Physical therapy at each clinic, 2) discussions and involvement with physical therapists in the clinic and 3) education of the training program and outcome measures to physical therapists who will be involved in the training.

An educational curriculum consisting of movies/pictures of the exercises and a clinical handbook of the program and its theoretical framework will be developed. In addition, a digital tool (webpage or mobile application) to disseminate the training program to physiotherapists will be developed through a series of developmental workshops using an ideation method. The participants of the workshops will consist of physiotherapists working with people with Parkinson's disease and familiar to group training. Data from the workshops will be collected through video and sound recordings as well as by observers and will be analyzed with qualitative content analysis. After developing the digital tool a pilot study will be performed with physiotherapists. Data will be collected through surveys, statistics from the digital tool and from focus groups (ethical approval 2015/1804-32). As a second step, a digital tool to promote balance training and physical activity in individuals will also be developed using the same technique i.e., developmental workshops with end-users (patients with Parkinson's disease), develop the tool and thereafter testing the tool with a pilot study.

Fidelity to the program will be assessed by process evaluation. This will be performed by investigating the compliance to the training for the patients and the adherance to the training concept itself and its theoretical framework in regards to the trainers/physical therapists. The patients compliance will be measured as number of sessions attending. For the trainers/physical therapist adherence to the concept and theoretical framework will be assessed by reviewing the documentation of the traing sessions (logbooks) and observations. Obeservations of trainers will be used to provide an insight into interactions and progression (Mulhall 2003), which makes it a preferable method when exploring what is happening during the training sessions. Barriers and

facilitators will also involve feasibility i.e., the extent of which the program is regarded as satisfactory in terms of content and complexity/challenging by the patients and trainers (Durlak and DuPre 2008).

In the implementation study, we will study facilitators and barriers to "real-world" implementation of the intervention. We will collect information on possible barriers that might have influenced the implementation of the program and facilitators that might have supported the implementation. This information can in turn be used to identify possible implementation strategies that can be used to facilitate the implementation of the program into current clinical practice. Both qualitative (focus groups and individual semi-structured interviews) and quantitative (questionnaires) methodologies will be posed to representatives of different stakeholders (patients, physiotherapists/trainers and managers/directors). By using several sources for data collection, triangulation can be achieved, which supports trustworthiness of the study (Patton 2002). To form the interview guide we will follow the guidelines posed by Durlak and DuPre (2008) with a focus on barriers and facilitators. The transcripts from the qualitative data will be analysed by the use of qualitative content analysis.

RELEVANCE

With an improved balance and gait, increased level of physical activity and an improved health related quality of life, individuals participating in the program will not only reduce their risk of falling, but also gain other health benefits related to an active lifestyle and, thereby, a good and active ageing. The results from this project will have an immediate application and clinical relevance for all elderly at risk of falling. Our evaluation methods and training program fills a gap in everyday clinical practice and will in a very near future, have the potential to reach a large number of elderly, and thus reduce the risk of falls and fall-related injuries.

The long-term goal of this project is to improve balance and gait ability in individuals with PD by exposure to a new challenging and progressive balance training program in combination with physical activity and thereby reduce the risk of falling. In the short-term perspective this proposed research could directly contribute to a change in focus concerning balance interventions in PD and other neurological disorders. In a medium perspective it has a potential to contribute to new clinical tests to balance disorders, physical inactivity and predict falls in elderly. An improvement in balance function, physical activity might prevent or postpone the incidence of a hazardous fall, thus reducing the burden on the health care system and the society as well as for the individual.

Our model for balance training and outcome methods will expand techniques and measurements tools available to physical therapists and other health care professionals treating and evaluating patients with balance disorders. In addition, participating in the study will increase the knowledge and skills of the clinicians and patients involved.

ETHICAL CONSIDERATIONS

As shown in the project plan some parts are already approved by the Regional board of ethics in Stockholm, dnr 2015/1804-32 and 2015/570-32. These have been applied for as an amendment to the former ethical approvals in the BETA project (2006/151-31, 2009/819-32, 2010/1472-32 and 2012/1829-32. We are now applying for ethical approvement from a broader perspective of the whole implementation part and are therfore incorporating also these parts since they are a part of theat perspective. In addition, the BETA projekct has divided into two parts: an osteoporosis part with Agneta Ståhle as PI and a Parkinson's disease part (BETA-PD) with Erika Franzén as PI. This application does only concern the BETA-PD part and therefore Erika Franzén is the main responsible researcher/PI.

We are conscious of the increased risks for falls compared to usual balance training of elderly and have taken special precautions by having 2 trainers and small group of 5-6 patients, we estimate the risk as very small in comparison to the benefit of the training.

CONTACTS AND COLLABORATION IN THIS PROJECT

The project is conducted by a multidisciplinary team of experts representing different disciplines (physical therapy, geriatrics, neurology and public health.The investigators and collaborators involved in this project possess a unique knowledge necessary for both clinical and laboratory research and implementation of the results. The investigators also have the clinical knowledge- and the patients- to transfer the results directly to the clinic in a multidisciplinary way.

Erika Franzén, is the principal investigator for this project, with main responsibility for project planning, administration, intervention, evaluation, writing papers, supervision of students at PhD, master and bachelor level. Dr. Franzén is an associate professor, has her own research group (http://ki.se/en/nvs/franzen-group) and holds a research associate position (forskarassistent-tjänst) from the Swedish Research Council. Dr. Franzén is head of the Motor Control Laboratory, Karolinska Institutet, KI, which have excellent resources for analyzing gait, balance and motion. Dr. Franzén is an expert in balance control and movement in elderly and Parkinson's disease, in both clinical and laboratory settings. Currently, she supervises four PhD students working fulltime within the project, three postdoc's and several master students. She also holds positions at Karolinska University hospital and Stockholms Sjukhem.

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