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ORIGINAL RESEARCH

Prediction of Falls in Subjects Suffering From Parkinson Disease, Multiple Sclerosis, and Stroke

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Abstract

Objective: To compare the risk of falls and fall predictors in patients with Parkinson disease (PD), multiple sclerosis (MS), and stroke using the same study design.

Design: Multicenter prospective cohort study.

Setting: Institutions for physical therapy and rehabilitation.

Participants: Patients (N=299) with PD (n=94), MS (n=111), and stroke (n=94) seen for rehabilitation.

Interventions: Not applicable.

Main Outcome Measures: Functional scales were applied to investigate balance, disability, daily performance, self-confidence with balance, and social integration. Patients were followed for 6 months. Telephone interviews were organized at 2, 4, and 6 months to record falls and fall-related injuries. Incidence ratios, Kaplan-Meier survival curves, and Cox proportional hazards models were used.

Results: Of the 299 patients enrolled, 259 had complete follow-up. One hundred and twenty-two patients (47.1%) fell at least once; 82 (31.7%) were recurrent fallers and 44 (17.0%) suffered injuries; and 16%, 32%, and 40% fell at 2, 4, and 6 months. Risk of falls was associated with disease type (PD, MS, and stroke in decreasing order) and confidence with balance (Activities-specific Balance Confidence [ABC] scale). Recurrent fallers were 7%, 15%, and 24% at 2, 4, and 6 months. The risk of recurrent falls was associated with disease type, high educational level, and ABC score. Injured fallers were 3%, 8%, and 12% at 2, 4, and 6 months. The only predictor of falls with injuries was disease type (PD).

Conclusions: PD, MS, and stroke carry a high risk of falls. Other predictors include perceived balance confidence and high educational level. Archives of Physical Medicine and Rehabilitation 2017;■:■■■-■■■

Neurologic disorders characterized by motor dysfunction and imbalance place affected individuals at risk of falls. Parkinson disease (PD), multiple sclerosis (MS) and stroke carry a high risk of falls. In PD, falls can be caused by abnormal dopaminergic striatal projections to axial muscles or involvement of globus pallidus with consequent impairment of postural tone and synergies, and increase in axial rigidity.[1,2] Subjects with this condition are reported with a 45% to 68% annual risk of falls, and two-thirds of them fall repeatedly.[3] Freezing of gait, symptomatic postural orthostasis, higher disease severity, and balance disorders are also predictors of falls.[3-5]

MS leads to mobility disturbances and balance disorders because of the multiple lesions that slow somatosensory conduction and impair central integration.[6] Italian investigators[7] found correlations between body sway and cerebellar and spinal cord atrophy. The relation between lesions and falls is still unclear, but

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>50% of patients with MS are fallers.[8] A systematic review comprising mostly retrospective studies found that compared with nonfallers, fallers with MS had a lower disability score, progressive course, use of walking aids, and poorer performances in static and dynamic balance tests.[8]

Stroke causes balance disorders because of inability to produce fast, accurate, and coordinated muscular patterns.[9,10] In this disease, 14% to 65% of individuals fall at least once while in hospital, and 37% to 73% fall during the 6 months after discharge.[11] In a recent prospective study involving 121 patients and collecting falls up to 6 years after stroke,[12] impaired activities of daily life and falls at 3 months were predictors of future falls.

Patients with PD, MS, and stroke have common risk factors for falls, including older age,[13-15] disease severity,[3,8,16] and functional disability.[17-19] However, published reports cannot be compared because of differing study populations and designs. In the absence of a unifying design, the 3 clinical conditions cannot be compared for fall frequency, and common risk factors cannot be separated from disease-specific risk factors. To our knowledge, there are no studies comparing the risk of falls and the risk factors in the 3 clinical conditions with the same design and methodology.

The aims of this study are as follows: (1) calculation of the risk of falls in 3 cohorts of patients, each represented by 1 of the 3 diseases; and (2) identification of risk factors for falls shared by PD, MS, and stroke and factors specific to each clinical condition.

We hypothesized that (1) risk of falling is different across the 3 neurologic conditions even after controlling for confounding factors (eg, age, sex, disease onset), and (2) common risk factors, and consequently common tools, for fall prediction can be identified.

Methods

This is a prospective cohort study conducted from February 27, 2013, to September 7, 2015, in 3 institutions for physical therapy and rehabilitation (Don Gnocchi Foundation [Milan], Don Gnocchi Foundation [Rome], S.Camillo Hospital [Venice]). Eligible patients were consecutive individuals with PD, MS, or stroke requiring rehabilitation for balance disturbances. Patients were recruited from the centers' in-hospital and ambulatory services. The diseases were confirmed by well-defined diagnostic criteria: UK PD Society Brain Bank criteria,[20] McDonald criteria of the International Panel on Diagnosis of MS,[21] and World Health Organization diagnostic criteria for stroke.[22] Excluded were patients having at least 1 among the following: (1) cognitive impairment (Mini-Mental State Examination[23] score<21), (2) major depression (*Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision*),[24] (3) severe joint and/or bone disorder interfering with balance and gait (clinical judgment), and (4) aphasia if interfering with the comprehension of the aims of the study and self-administered tests. Patients with MS should not have had a relapse within the previous 3 months. Stroke should have occurred at least 4 weeks before study entry. These limitations were required to exclude patients in the acute phase of the disease and accept only individuals with stabilized symptoms and signs.

List of abbreviations:

ABC	**Activities-specific Balance Confidence**
BBS	**Berg Balance Scale**
CI	**confidence interval**
CIQ	**Community Integration Questionnaire**
DGI	**Dynamic Gait Index**
IADL	**instrumental activities of daily living**
IQR	**interquartile range**
MS	**multiple sclerosis**
PD	**Parkinson disease**

After releasing written informed consent, each eligible patient was invited to a baseline visit to collect demographic and clinical factors implicated in the risk of falls. The examinations were all performed by experienced physiotherapists and/or psychologists. Demographic factors included age, sex, education, occupation, presence of partner or caregiver, presence of architectonic barriers, and disability status. Clinical factors included disease type and duration, use of walking aids, outdoor and indoor shoes, comorbidities and related treatments, urinary incontinence, history of falls (with and without complications) in the preceding 6 months and severity, and Modified Barthel Index score, ranging from 0 (full dependence) to 100 (full independence).[25] A number of clinical scales were used to test functional disability, including (1) balance (Berg Balance Scale [BBS] ranging from 0 [bad balance] to 56 [good balance] and Dynamic Gait Index [DGI] ranging from 0 [bad performances] to 24 [good performances]),[26] (2) walking abilities (Timed Up & Go test and 10-m walking test),[27] (3) performance during daily living activities (instrumental activities of daily living [IADL] ranging from 0 [completely dependent] to 8 [independent]),[28] (4) self-confidence with balance (Activities-specific Balance Confidence scale [ABC] ranging from 0 [bad confidence] to 100 [good confidence]),[29] (5) patients' adoption of fall prevention strategies (Falls Behavioral Scale ranging from 0 [bad fall prevention strategies] to 120 [good fall prevention strategies]) (appendix 1),[30] (6) protective behaviors (Falls Prevention Strategy Survey ranging from 0 [bad protective behaviors] to 22 [good protective behaviors]),[31] and (7) social integration (Community Integration Questionnaire [CIQ] ranging from 0 [no integration] to 29 [excellent community integration]).[32]

At baseline assessment, subjects were not included in any rehabilitation regimen; however, rehabilitation was not impeded in the following 6 months. Because balance rehabilitation during follow-up could bias the results, we collected information on treatments received in the 6 months after baseline and adjusted the data using rehabilitation as a confounder in multivariate analysis models.

Each patient was given a fall diary with details on time, circumstances, and complications of each fall, and was followed for 6 months with telephone contacts approximately at 2, 4, and 6 months. At each contact, the interviewer asked the patient to read the fall diary; the patient (or, if unavailable, the spouse or an informed caregiver) was also inquired on specific rehabilitation programs and any incurred falls, with date, circumstances, underlying cause, and related injuries.

A fall was defined as an unexpected event where the person inadvertently came to rest on the ground or other lower level.[33] Data were collected by trained interviewers and uploaded in an ad hoc web database located at the Mario Negri Institute, where the statistical analysis was performed. The main outcome measures were presence and number of falls. A patient was qualified as faller when experiencing at least 1 fall during follow-up, or recurrent faller after at least 2 falls. Patients with falls resulting in injuries were defined as injurious fallers.

Descriptive statistics were provided on the demographic and clinical variables in the entire sample and for each disease separately. Proportions and medians (with interquartile ranges [IQRs]) were used as appropriate. Demographic and clinical variables were compared between PD, MS, and stroke using the chi-square or Fisher exact test for categorical variables, and the Wilcoxon-Mann-Whitney