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Abstract

Background: Identifying causes of falls for people with Parkinson's disease has met with limited success. Prospective falls measurement using the 'gold standard' approach is challenging. This paper examines the process and outcomes associated with longitudinal falls reporting in this population.

Methods:
Participants were recruited from ICICLE-GAIT (a collaborative study with ICICLE-PD; an incident cohort study). Monthly falls diaries were examined over 48 months for accuracy of data and rate of attrition. To further inform analysis, characteristics of participants with 36 month completed diaries were compared with those who did not complete diaries.

Results:
One hundred and twenty-one participants were included at baseline. By 12 months, falls diary data had reduced to 107 participants; to 81 participants by 36 months; and to 59 participants by 48 months. Key reasons for diary attrition were withdrawal from ICICLE-gait ($n =16$) (13.2%), and non-compliance ($n=11$) (9.1%). The only significant difference between the completed and non-completed diary groups was age at 36 months, with older participants being more likely to send in diaries.

Conclusion: Prospective falls data is feasible to collect over the long term. Attrition rates are high; however participants retained in the study are overall representative of the total falls diary cohort.

Key words: Prospective, methodology, resources, older adults, neurological

Introduction

Parkinson's disease (PD) is a progressive disorder exhibiting cognitive, motor, and non-motor dysfunction. Motor symptoms commonly present unilaterally and progress bilaterally, with balance deficits developing 2-3 years later alongside an increasing risk of falls[1]. Cognitive impairment also increases risk of falling and further compounds the problem [2]. Falls are a major source of injury and fracture within this population [3,4] and can lead to reduced mobility, pain, increased caregiver stress and reduced quality of life [5]. Understanding the difficulties associated with falls reporting in this population is important because accurate information is required to characterise falls evolution over time and to chart the changing nature of falls and the features that predict falls as disease advances. Longitudinal data is critical therefore to help inform effective interventions [6].

Ascertaining falls information from older populations and people with Parkinson's disease (an age-related disorder) is challenging. Retrospective self-reporting of falls using telephone, face-to-face interviews or postal questionnaires[7] underestimate falls frequency due to inaccurate recall[8]. A broad range of formal and informal prospective data gathering methods have also been reported which include use of diaries, calendars or postcards to record falls events. Other methods include telephone interviews carried out between one and six monthly intervals, monthly out-patient follow-ups or monitoring of medical records and incident reports in residential settings. A recent review suggests that inconsistent reporting of falls rates across studies results in data inaccuracies which remain an issue even when robust monitoring is in place [9].

Attempts have been made to standardise falls reporting in older adult populations. ProFaNE (Prevention of Falls Network Europe) recommend that falls be reported monthly with telephone follow-up to confirm missing data [8,10,11]. This approach has also been used in PD, although follow-up time is limited. For example, in a randomised controlled trial of cognitively intact participants with PD, falls diary data loss of 13% was reported with withdrawal, death or missing data identified reasons for study attrition [6].

Important questions concerning prospective falls diary data remain. Little is known about magnitude of data loss over longer periods of time and if remaining data is biased, thereby threatening internal validity. We examined both these questions as key aims of the study. The first aim was to inspect falls diaries for accuracy of data and to report the rate of attrition over 48 months in an incident cohort of people with Parkinson's disease. The second aim was to compare baseline characteristics of participants who completed 36 months falls diaries with those who were unable to complete the diaries to identify any potential bias within the data.

Methods

Participants

Participants were recruited within 4 months (median) of receiving their Parkinson's disease (PD) diagnosis into the ICICLE-GAIT Study which is a collaborative study with ICICLE-PD, an incident cohort study (Incidence of Cognitive Impairment in Cohorts with Longitudinal Evaluation—Parkinson's disease) [12]. Details of participant demographics have previously been published [13]. The overarching aim of ICICLE-GAIT is to develop a predictive model to identify those at risk of cognitive decline, future falls and transition to PIGD phenotype. Participants were included if they demonstrated extrapyramidal signs (e.g. tremor, rigidity, bradykinesia), but were excluded if they had significant memory impairment, dementia, other causes of Parkinson's symptoms or poor grasp of the English language. Following ethical approval from Newcastle and North Tyneside Research Ethics Committee, participants were recruited between June 2009 and December 2011. 0f 150 potential participants *n*=12 declined participation, n=11 had comorbidities affecting gait and were not included and *n*=6 were excluded. Study participants (*n* = 121) underwent a comprehensive clinical assessment that included a broad range of clinical, demographic, gait and cognitive outcomes which have been described in full in previous publications[13,14]. All participants gave written informed consent. Two participants were later excluded due to a change of diagnosis (*n*=119).

Falls Reporting

Participants were asked to prospectively record falls using a standardised falls diary (Appendix 1). A fall was defined as an event which results in a person coming to rest inadvertently on the ground, floor or other lower level [8]. Monthly diaries were sent out in six monthly batches with pre-paid return envelopes. Participants were asked to send diaries back on a monthly basis, record if they had fallen or not within the previous month, and were encouraged to fill in details of the fall as soon as possible after the event. If a fall occurred they were asked to specify date and time, location, preceding activity, possible cause, how they landed and how they recovered themselves. An electronic diary option was available, although no one used this. Individual diary data, falls events, follow up calls, and participant feedback were logged on an Excel database. If documentation was unclear, a follow-up telephone call was made to clarify information as recommended by ProFaNE [8]. Prompts to return missing diaries were also made via a follow-up telephone call bi-monthly. Messages were left if we were unable to contact participants and all calls were documented for transparency. If participants could not be contacted following three attempts, they were categorised as "incomplete diaries". We did not use a standardised, scripted telephone call procedure but a similar question structure was use for all participants. A pragmatic decision was made by the research team that multiple fallers (who we defined as having more than four falls a month) would no longer be required to send diaries because of potential inaccuracies from frequent reporting.

Falls diary attrition

A data audit was completed to assess availability of falls diary data at different time points and missing data was identified at 12, 18, 36 and 48 months. To minimise data loss, we attempted to re-contact participants who had recently stopped sending diaries to ascertain falls status. For some participants we were able to use either their study visit or clinical notes to determine their falls status. In several cases data could not be verified, and the team made a decision about falls status on a case by case basis in order to determine whether it could be used in analysis. If we could not clarify them as a faller they were counted as loss to follow-up.

Data Analysis

A flow chart was used to describe attrition of falls diaries over 48 months and reasons for loss were categorised to aid understanding of the data. We included participants who had fallen and subsequently stopped sending diaries into the 'completed diaries' group (*n* = 19). This decision was based on our data (60 participants had fallen more than once at 48 months, 12 people had fallen once but then withdrew/ were lost to follow-up, only 4 participants had only one fall in the 48 months), and the high probability that fallers would continue to fall [15].

At 36 months, 100 participants (81 with complete diaries + 19 fallers with usable data) comprised the 'complete diaries' group compared to 19 with incomplete diaries. The total number of participants used in this analysis was *n*=119 (due to 2 later exclusions).

We compared demographic, motor and cognitive variables at baseline for participants with 36 months completed versus non-completed diaries. We used 36 rather than 48 months for this comparison because of high 48 month attrition reducing power. Due to the small size of the groups all continuous variables were analysed using nonparametric tests for independent samples (Mann U Whitney). All between group differences were compared using a Chi-squared test. SPSS® 21.0 was used to analyse data with alpha set <0.05.

Results

Falls diary attrition

We assessed 121 participants at baseline. Falls diary data had reduced to 107 participants by 12 months; to 81 participants by 36 months; and to 59 participants by 48 months. Losses were grouped into eight categories: Withdrawn/ excluded, deceased, non-compliance, multiple fallers, time constraints, loss to follow-up, illness and admitted to care-home. The key reason for diary attrition was withdrawal from the study (*n* =23) which continued steadily throughout the study period (Fig 1 and Table 1). Non-compliance was recorded as the second most substantial reason (*n*=19) for data loss.

Comparison of clinical characteristics for participants with complete versus incomplete diaries

When both groups were compared, there was a significant difference for age ($p=.007$), with those in the active diary group older by an average of almost nine years. There were no significant differences for any other characteristics, including disease severity (UPDRS III) and mild cognitive impairment (MCI) (Table 2).

Discussion

To our knowledge this is the first study to systematically inspect falls diaries data accuracy and diary attrition in PD over 48 months. Results from this study contribute to knowledge concerning the feasibility of falls diaries in longitudinal PD cohorts.

Individual reasons for non-completion of diaries were varied but categorisation further informed our understanding, with withdrawal from ICICLE-GAIT and non-compliance predominating. Compliance may have been reduced because of the detail expected within the diaries. Open questions allow detailed description of falls however complex questions can lead to incomplete data. In keeping with earlier recommendations we used timely telephone follow-ups to keep this data loss to a minimum [16]. Time constraints are an issue for participants and carers, and researchers need to explore options for data collection to minimise time commitment. Software options such as apps or on-line options could be considered and have been used previously with this population [17], although as noted earlier no-one accepted the opportunity in this study to send in e-diaries. Older participants were significantly better at sending in diaries, which concurs with earlier work showing that older adults are more likely to comply with therapeutic interventions compared to younger people [18]. Years of education has previously been suggested as a reason for poor diary completion however this view emerged in response to a study whereby participants who did not return diaries were assumed not to fall [16].

After the 12 month assessments missing data increased as would be expected in participants with a progressive disorder. The attrition rate of over 12 months is broadly comparable to earlier work [19] which reported 13% attrition of diaries collected over 6 months. Overall attrition rate over 4 years appeared high, however, to our knowledge this study provides the longest follow up period to date and therefore it is difficult to

draw comparisons. Our results show that despite high attrition, group characteristics for participants who remained in the study were comparable to those who withdrew other than for age. This provides some confidence in interpreting data going forward although any subgroup analysis is compromised.

Broader challenges associated with prospective falls data

In a recent review of recurrent falls in PD the authors noted that most falls studies reviewed (14 papers; 64%) used a diary/ calendar type system [9]. Protocols from these studies indicated that data were collected prospectively for an average of 12 months. Our experience suggests that on-going costs and staff time for database maintenance should not be underestimated. Inclusive of initial diary administration; postage, follow up calls, data entry and data checking we would estimate staff time as 10 hours per week. However, costs attenuated due to the reduced number of participants. Secondly, previous studies report high variability in number of falls and the details surrounding them. Data accuracy varies as a function of fall frequency, suggesting this is a potential issue. Allen's review indicates that participants with multiple falls are less likely to record them accurately especially if they are not recorded immediately [9]. To reduce this risk, we ensured participants understood a fall as defined by the World Health Organisation [20]. We also discussed needing to know about all falls and not just ones they perceived occurred due to their Parkinson's symptoms. In addition, we emphasised the need for timely recording of the event. We also contacted participants to follow-up on the information contained in the diary for ambiguous entries. If participants were having over four falls a month a pragmatic decision was taken by the team that participants would stop filling in diaries due to the burden of reporting for frequent fallers.

An increasing risk of falls is associated with reducing odds of returning diaries. Missing data may not be missing at random which may produce biased data. Every effort was made to clarify if participants were fallers or non-fallers. In several cases data could not be clarified and the team assessed the available information on a case by case basis in order to determine whether it could be used in analysis. However if clarification was not

obtained and information was missing, the data was included in the non-completed diary group.

This study also raises the issue of falls classification, which is routinely reported as single or recurrent falls status. Earlier work by our group examining the association between levels of activity and falls data from the ICICLE-GAIT cohort reported a significant association when fall type but not fall frequency was considered within the falls typology [21]. The underlying premise was that a fall that occurs during a high level activity such as skiing or fell walking is different to a fall that occurs during a low level activity such as moving from one position to another. We have shown that it is feasible to collate very specific and detailed information about falls which allows a more refined classification. Future studies may incorporate this phenotyping to enhance analysis and aid interpretation.

A final comment relates to generalisability. To our knowledge, prospective falls studies in older adults using a gold standard approach have not extended beyond collecting short term prospective data [7]. However, we anticipate that the methodology used in our study is broadly applicable to falls research not just for people with PD but also for older adults. Critically, sufficient resources must be allocated.

Limitations

For data analysis, we assumed that participants who fell would continue to fall and if they stopped sending in diaries their classification as faller was retained. However, as noted earlier it is unlikely that a person with PD who falls will transition to a non-faller.

 Conclusions

Longitudinal use of falls diaries is feasible, and although attrition rates are high participants retained in this study were clinically and demographically similar to those who withdrew.

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Figure 1. Flow Chart of Diary Data Loss

Table 1 Falls Diary Attrition Rate

	12 m	18 m	36 m	48 m
Numbers of available patient data ($n =$)	107	98	81	59
% attrition from total ($n=121$)	11.5%	19%	33%	51%

Table 2 Comparison of variables from completed/ non-completed diaries

	Complete diaries 36 months ($n=100$)	Incomplete diaries 36 months ($n=19$)	CI	*P*
Age	69.1 (61.5,75.6)	60.6 (50.8, 68.9)	(.005; .008)	**.007**[a]
Gender	Male (57.1%) ($n=68$)	Male (9.2%) ($n=11$)	(.425; .444)	.433[b]
Years of Education	12 (10, 16)	12 (10, 18)	(.729; .746)	.736[a]
Retired/ working	Work (31.9%) Retired (52.1%)	Work (7.6%) Retired (8.4%)	(.602; .621)	.610[c]
GDS	2.0 (1, 4)	2.0 (0, 4)	(.745; .762)	.746[a]
MCI level 1	MCI- (45.1%) MCI+ (38.1%)	MCI- (9.7%) MCI+ (7.1%)	(.799; .814)	.806[b]
MoCA	26 (23,28)	28 (22,29)	(.432; .451)	.438[a]
UPDRS II	11 (6,13.75)	10 (6, 13)	(.615; .634)	.613[a]
UPDRS III	25 (18, 31)	23 (15, 37)	(.860; .873)	.867[a]
Motor Phenotype	PIGD (42%) ID (7.6%) TD (34.5%)	PIGD (4.2%) ID (1.7%) TD (10.1%)	(.120; .134)	.127[b]

$n=119$ participants. Values presented are median (25%, 75% Interquartile Range)

Significant findings ($p<0.05$) are highlight in bold, a Mann Whitney U test, 2 tailed; b Chi-square Fisher's exact test, 2 sided; c Pearson Chi-square, 2 sided; % of total; *p* relates to the group differences; CI = Lower and upper 95% confidence intervals. UPDRS, United Parkinson's Disease Rating Scale; GDS, Geriatric Depression Scale; MoCA, Montreal Cognitive Assessment; MCI, Mild cognitive Impairment; PIDG, Postural Instability and Gait disorder group; ID, indeterminate phenotype

Appendix 1:

ICICLE –GAIT RESEARCH PROJECT FALLS DIARY

Have you experienced a fall over the past month Yes/No?

If 'yes', what was the date and time of fall-event?…………………………………

If you have experienced a fall, please answer the following questions:

Where were you when you fell?
What were you doing or trying to do at the time?
What do you think caused the fall?
How did you land on the floor?
How did you get back up from the floor?