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Short communication

# Incidence and risk factors of institutionalisation in Parkinson's disease and atypical parkinsonism

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ABSTRACT

*Introduction:* The basic epidemiology of institutionalisation (the need for long-term care in an institution) in parkinsonism is unclear. We aimed to identify the incidence of, and risk factors for, institutionalisation in Parkinson's disease (PD) and atypical parkinsonism (AP).

*Methods:* We analysed data from a prospective population-based incidence cohort of parkinsonism in North-East Scotland (the PINE study). 556 newly-diagnosed participants (PD, N = 200; AP, N = 98; controls, N = 258), recruited between 2002 and 2009, were prospectively followed life-long with data collection on place of residence. We determined the incidence and baseline predictors of institutionalisation using Cox regression.

*Results:* The median follow-up time was 9.3, 4.4, and 10.8 years in PD, AP, and controls respectively. 70 (35 %) PD, 53 (54 %) AP, and 43 (16 %) controls became institutionalised. The incidence rates of institutionalisation in PD, AP, and controls were 5.1, 20.8, and 1.8 per 100 person-years respectively. The median time to institutionalisation was 11.8 years in PD and 3.5 years in AP. Multivariable Cox regression showed that AP (HR versus PD = 3.05 [95 % CI 1.90,4.91]), increasing age (HR for 10-year increase = 1.82 [95 % CI 1.40,2.36]), poorer cognition (HR for MMSE<24 versus MMSE>27 = 2.62 [95 % CI 1.45, 4.73]), more-severe parkinsonian impairment (UPDRS part 3) (HR for 10-point increase = 1.25 [95 % CI 1.05, 1.48]) were independently associated with higher hazards of institutionalisation. Sex, co-morbidity, smoking history, and living alone were not associated with institutionalisation.

*Conclusion:* Institutionalisation is much more frequent in parkinsonism, particularly in AP, than in controls. AP, older age, severe parkinsonian impairment, and poorer cognition were independent baseline predictors of institutionalisation.

## 1. Introduction

Parkinson's disease (PD) and neurodegenerative causes of atypical parkinsonism (AP) are progressive disorders which often lead to disability and need for care [1]. Care may be provided at home by relatives or professional carers, but this is not always available or sufficient to maintain living at home, necessitating long-term care in an institution, such as a nursing home. Such care is expensive and is a major economic burden for patients or society [2]. Knowledge of the incidence of institutionalisation and identification of its risk factors can help health service planners to predict future care needs. Furthermore, if these risk factors are modifiable, this could also lead to reducing the need for institutionalisation, benefitting patients and reducing the economic burden.

Few studies have investigated the incidence of, and risk factors for, institutionalisation in PD. Even less is known about institutionalisation in AP. Few other studies have investigated institutionalisation in AP [3,4] and the only data on predictors of institutionalisation is in one study which examined a single prognostic factor (apathy) in dementia with Lewy bodies [3]. We previously described the development of institutionalisation in PD and AP versus controls in the Parkinsonism Incidence in North-East Scotland (PINE) study [5]. In this report we aimed to:

1. Describe the incidence of institutionalisation in PD and AP compare with controls, with longer follow-up than in our previous analysis including diagnostic revisions.
2. Identify risk factors for institutionalisation in PD and AP measured at or close to the diagnosis of parkinsonism.

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## 2. Methods

### 2.1. Study population, design, and clinical characteristics

The PINE study is a prospective, population-based, incidence cohort that sought to identify and follow-up all newly diagnosed patients with degenerative or vascular parkinsonism in Aberdeen, Scotland between 2002-4 and 2006-9 [5]. All incident patients were invited to undergo lifelong in-person annual follow-up. An age-sex matched community-based control group was also recruited. At baseline, and at each annual visit, data are collected on demographics, clinical history, and non-motor symptoms, a structured clinical examination and several questionnaires. Data on key outcomes are collected, including survival, dependency, dementia, and institutionalisation [5]. Diagnoses were re-evaluated annually and were guided by appropriate diagnostic criteria. This analysis was restricted to PD, AP (Dementia with Lewy bodies (DLB), Dementia with associated parkinsonism, progressive supranuclear palsy (PSP), corticobasal degeneration (CBD), multiple system atrophy (MSA), and vascular parkinsonism) and controls.

### 2.2. Potential prognostic factors

We chose the baseline prognostic factors (that is, data collected at baseline study visit which was at or very close to diagnosis) based on previous published studies and the data available in our dataset. The prognostic factors included: (i) age; (ii) sex; (iii) smoking history in pack-years; (v) whether the patient lived alone or not; (iv) parkinsonian impairment (UPDRS part 3 (motor) score); (v) disease stage (Hoehn and Yahr scale); (vi) disability (Schwab and England ADL scale); (vii) co-morbid conditions (Charlson co-morbidity index); (viii) cognitive function (MMSE). A MMSE score less than 24 is commonly used to suggest dementia and the mean MMSE score in normal healthy adults is 27.8 [6], and so we divided the MMSE score into three categories: less than 24, from 24 to 27 and from 28 to 30.

### 2.3. Outcome

The event of interest was institutionalisation, defined as entry to a nursing home, residential home, or long-stay hospital ward. Place of residence was ascertained at each annual visit and at death. If the participant had been institutionalised the date of entry was confirmed with the patient, the next of kin, or the institution itself so the exact date of entry was available in almost all cases.

### 2.4. Statistical analysis

Kaplan-Meier (KM) survival curves were plotted and the incidence rates of institutionalisation were calculated. Missing baseline data were imputed by multiple imputation. Multivariable Cox regression models were built to identify potential prognostic factors in PD and AP. Patients were censored when lost to follow-up, when they died without being institutionalised, or if alive on 31 March 2020 and not institutionalised. Detailed statistical methods are provided in the Supplementary Appendix.

We grouped the AP syndromes together for the main analyses because the individual numbers were small and they all have more rapid progression than PD, but we also reported incidence rates separately for each syndrome.

The study was approved by the NHS Grampian Research Ethics Committee and the Multicentre Research Ethics Committee A for Scotland.

## 3. Results

201 patients with PD, 114 with AP (36 DLB, 11 MSA, 31 PSP/CBD, 3 Dementia with associated parkinsonism, 33 Vascular parkinsonism), and 260 controls were recruited. One PD patient, 16 with AP, and 2 controls were already institutionalised at baseline and were excluded from the analyses, leaving 200 patients with PD, 98 with AP, and 258 controls remaining in the analysis. These numbers are slightly different from our previously published data on institutionalisation because of diagnostic reclassification. A summary of baseline characteristics and outcomes is given in Table 1. The median follow-up time in each group was 9.3 years in PD, 4.4 years in AP and 10.8 years in control group.

### 3.1. Incidence of institutionalisation

Of those who were not institutionalised at baseline, 70 (35 %) PD patients, 53 (54 %) AP patients and 43 (16 %) controls entered an institution during follow-up. There were 401 deaths during follow-up and 6 were lost to follow up for institutionalisation status (3 in PD and 3 in control group). Fig. 1 shows the KM curves in three diagnostic groups (PD, AP, controls) and by individual diagnosis in the AP patients. Patients with AP had the highest probability of institutionalisation at all time points after baseline and PD had higher probability of institutionalisation than controls. The median time to institutionalisation in PD and AP was 11.8 years and 3.5 years respectively, but was not reached in the control group. The incidence rates of institutionalisation in PD, AP, and controls were 5.1 (95 % confidence interval [CI] 4.0, 6.4), 20.8 (95 % CI 15.9, 27.3), and 1.8 (95 % CI 1.4, 2.4) per 100 person-years respectively. The incidence of institutionalisation in individual AP syndromes are shown in Supplementary Table 1.

### 3.2. Predictors of institutionalisation

Although the models we compared had similar performance, the

**Table 1**
Baseline characteristics and outcomes in the PINE study.

| | Parkinson's disease (N = 200) | Atypical parkinsonism (N = 98) | Controls (N = 258) |
|---|---|---|---|
| **Baseline characteristic** | | | |
| Age (years), mean (SD) | 72.6 (10.3) | 77.9 (7.3) | 75.3 (9.2) |
| Male, n (%) | 123 (61.5 %) | 64 (65.3 %) | 159 (61.6 %) |
| Smoking history in pack-years, median (IQR)[a] | 0.0 (0.0,15.2) | 2.8 (0.0,33.8) | 4.1 (0.0,28.7) |
| Living alone, n (%) | 50 (25.0 %) | 35 (35.7 %) | 86 (33.3 %) |
| UPDRS part 3 (motor) score, median (IQR) | 24 (16,32) | 29 (23,41) | 2 (0,5) |
| Hoehn and Yahr scale, median (IQR) | 2.5 (2.0,3.0) | 3.0 (2.5,4.0) | NA |
| Schwab and England ADL scale, median (IQR) | 90 (80,95) | 70 (50,80) | 100 (95,100) |
| Charlson co-morbidity index, median (IQR) | 1 (0,2) | 1 (0,2) | 1 (0,2) |
| MMSE test score, median (IQR)[b] | 29 (28,30) | 23 (18,27) | 29 (28,30) |
| **Outcomes** | | | |
| Institutionalised at baseline n (%)[c] | 1 (0.5 %) | 16 (14 %) | 2 (0.8 %) |
| Institutionalised during follow-up n (%) | 70 (35 %) | 53 (54.1 %) | 43 (16.7 %) |
| Death, n (%) | 163 (81.5 %) | 98 (100 %) | 140 (54.3 %) |
| Lost to follow-up, n (%) | 3 (1.5 %) | 0 (0 %) | 3 (1.2 %) |

[a] N missing = 6 (2.3 %).
[b] N missing = 24 (8.1 %).
[c] These participants are excluded from the other rows in this table and the denominator for the percentages in this row was 201 for PD, 114 for atypical parkinsonism, and 260 for controls. Abbreviations: ADL = activities of daily living; IQR = interquartile range, MMSE = minimental state examination; NA = not applicable; SD = standard deviation; UPDRS=Unified Parkinson's disease rating scale.

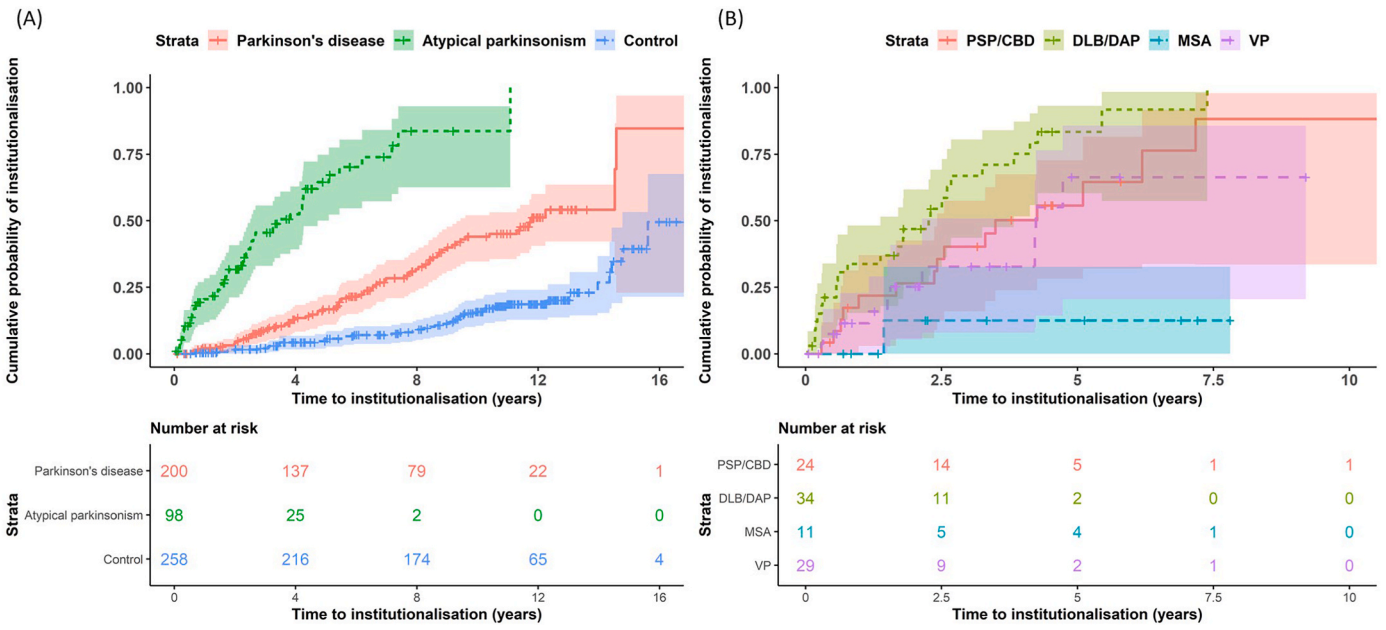


**Fig. 1.** Kaplan-Meier survival curve of probability of institutionalisation with 95 % confidence limits and the at-risk table in PD, AP, and controls (A); and in individual atypical parkinsonism syndromes (B).
**DLB = Dementia with Lewy bodies; DAP = Dementia with associated parkinsonism; MSA = Multiple system atrophy; PSP=Progressive supranuclear palsy; CBD= Corticobasal degeneration; VP= Vascular parkinsonism. Note: Only 2 patients with CBD, so combined with PSP. Only 3 patients with DAP, so combined with DLB.**

model including UPDRS but not the Hoehn & Yahr and Schwab and England ADL scales had the best fit (lowest AIC and BIC). We found no evidence of non-linearity in the continuous variables (see Supplementary Table 2).

The final adjusted Cox model showed that the significant risk factors were AP (HR versus PD = 3.05 [1.90,4.91]), increasing age (HR for a ten-year increase = 1.82 [1.40, 2.36]), UPDRS part 3 (motor) score (HR for a ten-point increase = 1.25 [1.05, 1.48]), and MMSE score less than 24 (HR versus MMSE>27 = 2.62 [1.45, 4.73]) (see Supplementary Table 3). Sex, smoking habit, co-morbidity and living alone status were not associated with institutionalisation.

## 4. Discussion

We found that the incidence rate of institutionalisation in AP and PD was much higher than in controls, and in AP was substantially higher than in PD. After adjusting for confounders, the hazards of institutionalisation in AP were over 3 times higher than for patients with PD. AP patients also had a much shorter median time to institutionalisation. MSA seemed to have a lower incidence of institutionalisation than other forms of AP (perhaps because of a lower risk of dementia), but this should be interpreted cautiously given the small numbers with each syndrome. Increasing age, more-severe parkinsonian impairment (higher UPDRS part 3 score), and poor cognition (MMSE <24) at baseline were also independently associated with risk of institutionalisation.

### 4.1. Comparison with previous literature

Several previous studies have reported institutionalisation in PD, but, to our knowledge, no other published studies have reported rates of institutionalisation in AP in general, or specific AP syndromes. This is the first study to report the incidence rate of institutionalisation in both PD and AP. Two previous inception studies have reported the development of institutionalisation. Our finding of a median time to institutionalisation of 11.8 years in PD was longer than in one previous inception study which had a median time to institutionalisation of between 6 and 8 years [7]. The other previous inception study had a lower risk of institutionalisation with only 23 % of participants being institutionalised by 10 years [8]. The lower risk over time in the study by Hely and colleagues may be because it was based on follow-up of a clinical trial, and such cohorts are often unrepresentative of the general population [8,9]. The higher risk of institutionalisation over time in the study by Parashos and colleagues [7] may be due to the earlier time of recruitment (patient diagnoses 1979–1988) and declining use of nursing homes in the general population over time [10].

A comparison with previous studies which investigated risk factors for institutionalisation, identified in a literature review, is summarised in Supplementary Table 4, although most previous studies were based on non-inception cohorts and so risk factors were not assessed at diagnosis.

### 4.2. Strengths and limitations

This study has several important strengths. The PINE study is a population-representative cohort of newly diagnosed patients with parkinsonism in Aberdeen, Scotland. Because we tried to identify and follow-up all new patients in northeast Scotland with high consent rate to follow-up (94 %) and only 6 participants (1 %) lost to follow-up for institutionalisation status, the risk of selection bias is very low. It also has a large sample size compared to previous studies of institutionalisation and few previous studies have studied patients from inception [7,8]. The follow-up was longer than most previous studies of institutionalisation in PD patients. We also used rigorous statistical methods, including reporting the numbers lost to follow-up, using multiple imputation, using survival analysis rather than logistic regression, careful testing of model assumptions, and choice of candidate predictors based on the literature instead of selecting statistically significant predictors [11].

However, there are some limitations of this study. Due to parkinsonism being more common in elderly people, the PINE cohort has few young-onset patients. We only studied baseline predictors, but changes after baseline and features which develop after baseline may also be important predictors. We were not able to study several potential prognostic factors, such as frailty or other factors relating to social

support, because of limitations in data availability. Additionally, there were insufficient data to distinguish between different types of AP in terms of risk factors and the institutionalisation incidence data. There will inevitably be some diagnostic inaccuracy [12] but we have sought to minimise diagnostic inaccuracy by careful long-term clinical assessment guided by formal diagnostic criteria and offering post-mortem diagnostic confirmation to all the patients in the study. We also note that our analyses did not include those who were institutionalised at baseline, so the true cumulative incidence will be higher than the reported incidence.

### 4.3. Further work

It would be useful to investigate risk factors of institutionalisation in a larger sample size. For example, using individual participant data meta-analysis to identify risk factors in different studies and pool the overall estimates can give more power for modelling and provide more generalisable results. Since baseline factors may change over time, including these changes in clinical features over time in a dynamic prediction model may improve predictions compared with a baseline prognostic model. For example, change in living alone status, loss of functional independence, loss of balance, development of fractures, or the emergence of incontinence, psychosis, or dementia may have important predictive value. Development of a valid prognostic model may allow better individualised risk prediction and may be useful in clinical management. Given that parkinsonian impairment and cognitive impairment were risk factors for institutionalisation it is important to investigate whether optimisation of treatment or cognitive rehabilitation could delay institutionalisation.

### 4.4. Conclusion

In conclusion, institutionalisation is more frequent in parkinsonism, particularly in AP than in controls. We found that AP and older age, more severe parkinsonian impairment, and poorer cognition at baseline were independently associated with institutionalisation. Further work to look at prognostic factors later in the disease course and whether modification of prognostic factors could delay or reduce institutionalisation is important.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.parkreldis.2023.105928.

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