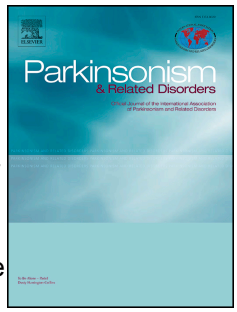
Measuring the burden and mortality of hospitalisation in Parkinson's disease

Low, Vincent; Ben-shlomo, Yoav; Coward, Elena; Fletcher, Suzanne; Walker, Richard; Clarke, Carl E.

DOI:
10.1016/j.parkreldis.2015.01.017

Accepted Manuscript



Measuring the burden and mortality of hospitalisation in Parkinson's disease: a cross-sectional analysis of the English Hospital Episodes Statistics database 2009-2013

Vincent Low, MRCS, MFPM, Yoav Ben-Shlomo, FFPH, Elena Coward, BSc, Suzanne Fletcher, RGN, Richard Walker, MD, FRCP, Carl E. Clarke, MD, FRCP

PII: S1353-8020(15)00052-8

DOI: 10.1016/j.parkreldis.2015.01.017

Reference: PRD 2564

To appear in: *Parkinsonism and Related Disorders*

Received Date: 10 November 2014

Revised Date: 12 January 2015

Accepted Date: 29 January 2015

Please cite this article as: Low V, Ben-Shlomo Y, Coward E, Fletcher S, Walker R, Clarke CE, Measuring the burden and mortality of hospitalisation in Parkinson's disease: a cross-sectional analysis of the English Hospital Episodes Statistics database 2009-2013, *Parkinsonism and Related Disorders* (2015), doi: 10.1016/j.parkreldis.2015.01.017.

Measuring the burden and mortality of hospitalisation in Parkinson's disease: a cross-sectional analysis of the English Hospital Episodes Statistics database 2009-2013

Vincent Low[1], MRCS, MFPM, Yoav Ben-Shlomo[2] FFPH, Elena Coward[1], BSc, Suzanne Fletcher[1], RGN, Richard Walker[3,4], MD, FRCP, Carl E Clarke[5,6], MD, FRCP

1. UCB Pharma Ltd, 208 Bath Road, Slough SL1 3WE, UK
2. School of Social and Community Medicine, University of Bristol, 39 Whatley Road, Bristol BS8 2PS, UK
3. Northumbria Healthcare NHS Foundation Trust, North Tyneside General Hospital, Rake Lane, North Shields, Tyne and Wear, NE29 8NH, UK
4.Institute of Health and Society, Newcastle University, Framlington Place, Newcastle upon Tyne, NE1 7RU
5. School of Clinical and Experimental Medicine, College of Medicine and Dental Sciences, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK
6. Department of Neurology, Sandwell and West Birmingham Hospitals NHS Trust, City Hospital, Birmingham, B18 7QH, UK

Correspondence to: Professor C E Clarke, Department of Neurology, City Hospital, Dudley Road, Birmingham, B18 7QH, United Kingdom.

Email: carlclarke@nhs.net Tel: 0044 (0) 121 507 4073 Fax: 0044 (0) 121 507 5442

Word count: Text: 2936 Abstract: 249

Running title: PD hospitalisation in England (Count = 29)

Key words: Parkinson's disease; hospitalisation; mortality; health economics.

Financial Disclosure/Conflict of Interest: C. E. Clarke: Advisory Boards: AbbVie, Britannia, Lundbeck, Teva, UCB; Honoraria: AbbVie, Britannia, Lundbeck, Teva, UCB;

Educational grants: AbbVie, Britannia, GE Healthcare, Lundbeck, Medtronic, Teva. R.W. Walker: Advisor Boards: AbbVie, Britannia, Teva; Honoraria: GSK, Lundbeck, Teva, UCB. V. Low, E. Coward & S. Fletcher are employees of UCB Pharma Ltd.

Funding sources for study: UCB provided funding to obtain the relevant HES data from Health IQ.

Summary

Background Patients with Parkinson's disease have higher hospital admission rates than the general population. We examined the reasons for admission, length of stay, costs, and in-hospital mortality in a national sample of Parkinson's disease patients.

Methods We used hospital admission data from the English Hospital Episodes Statistics database (2009 to 2013). Patients with Parkinson's disease or Parkinson's disease dementia and aged over 35 years were compared to all other admissions, excluding the above, with the same age criteria. We examined reasons for admissions (ICD-10), length of stay and in-hospital mortality. We used indirect standardisation and Poisson modelling to derive proportional ratios adjusting for age group and sex.

Results There were 324,055 Parkinson's disease admissions in 182,859 patients over 4 years which included 232,905 non-elective admissions (72%). This resulted in expenditure of £907 million (£777 million for non-elective admissions). The main reasons for admission were pneumonia (13.5%), motor decline (9.4%), urinary tract infection (9.2%), and hip fractures (4.3%). These conditions occurred 1.5 to 2.6 times more frequently in patients than controls. Patients with Parkinson's disease were almost twice as likely to stay in hospital for more than 3 months (ratio 1.90, 95% CI 1.83, 1.97) and even more likely die in hospital (ratio 2.46, 95% CI 2.42, 2.49).

Conclusions Parkinson's disease patients in England have higher rates of emergency admissions with longer hospital stays, higher costs and in-hospital mortality. Urgent attention should be given to developing cost-effective interventions to reduce the burden of hospitalisation for patients, carers and healthcare systems.

INTRODUCTION

With the ageing of the population in developed countries, the number of people affected by Parkinson's disease (PD) will rise[1] with the inevitable dramatic increase in healthcare costs of hospitalisation. A greater understanding is required about the whole process of hospitalisation in PD patients including why they are admitted, what happens during admission, and what happens on discharge. Only then can we develop improved processes to prevent or better manage hospitalisation.

Most previous studies have examined PD admissions to individual hospitals,[2-6] with relatively small sample sizes. One recent regional study from New South Wales, Australia documented the reasons for 5,637 admissions over a 4 year period.[7] The largest study came from an administrative database study in Ontario, Canada in 2003 with 15,304 PD patients. This showed that PD led to increased hospital admissions, longer admissions, higher drug costs, and higher physician costs.[8] There is a need for an up-to-date examination of PD admissions on a nationwide basis to inform healthcare planning.

We have examined the English Hospital Episode Statistics (HES) data on all admissions related to PD over a 4 year period to establish the size of the problem, the direct healthcare costs of admissions, the reasons why patients were admitted, and hospital mortality with the aim of recommending initiatives to reduce the burden of PD admissions.

METHODS

Data source

The HES database contains records including patient admissions, outpatient appointments and accident and emergency (A&E) attendances at healthcare providers (predominantly hospitals) in English NHS hospitals and English National Health Service (NHS) commissioned activity in the independent sector.[9] This includes zero bed days (ZBDs), where patients were admitted and discharged within 24 hours. These data are submitted to allow hospitals to be paid for the services they deliver.

For this study, hospital admissions within the HES database between 1st April 2009 and 31st March 2013 were extracted. The data was anonymised, so the study constituted a service evaluation which did not require ethical committee approval. Diagnoses were recorded using the International Classification of Diseases, 10th Revision (ICD-10). The main reason leading to an admission was coded as the primary diagnosis. Only one primary diagnosis was permitted for each admission, but up to 19 different secondary diagnoses were allowed. The secondary diagnosis was any condition that existed in addition to the primary reason as deemed relevant.

We extracted data on patient count, admission count (finished admission episodes), cost of admission, type of admission (elective/non-elective), coded reasons for admissions, in-hospital mortality, length of stay (LOS) and stays of greater than three months of duration. Average LOS was calculated by dividing total bed days by the total number of admissions. ZBDs were excluded from all analyses except original

headline rates to avoid skewing of the data and because these short admissions have less clinical and economic impact.

Parkinson's disease patients and controls

Patients with PD were identified by ICD-10 codes of G20X (Idiopathic PD) or F02.3 (Dementia in PD) either as a primary or secondary diagnosis. Patients under 35 years were excluded as PD is rare in this age group and may reflect coding errors. The control group consisted of patients with admission codes excluding the ICD-10 codes G20X and F02.3 in any diagnostic field and fulfilling the same age criteria.

Assigning admissions to a specific 'HES year' is complex, as patients may already be in-patients at the start of the year or discharged after the end of the year. For all analyses, except mortality, patients who began their admission before the study start date, but were discharged during the study period, were included (0.3% of total admissions), but patients who were not discharged by the study end date were excluded (2.0% of total) as cost and LOS can only be calculated within HES for completed admissions.

For the mortality analysis, only admissions occurring entirely within the 4 year study period were used to ensure the appropriate denominator, (i.e. a patient would have to be admitted and discharged or died within the 4 year study period).

Admission costs and excess bed days

Admission costs were calculated by applying the Healthcare Resource Group (HRG) for each inpatient stay to the Payment by Results (PbR) rules, the admission method

and other details of the hospital stay. This included HRG unit cost and any payments because of unexpectedly long hospital stay, or for any specialist care or additional treatments and tests. Prices were drawn from the corresponding year of the PbR national tariff. HRGs are standard groupings of clinically similar treatments which use common levels of healthcare resource. This method is used by healthcare providers to calculate reimbursement within the NHS. Each HRG has a maximum expected LOS and any stay in hospital beyond this 'upper trim point' is paid on a per day basis using a specific excess bed days (EBD) tariff which is different for each HRG. EBDs highlight exceptionally long inpatient stays.

Reasons for non-elective admissions

Common reasons for non-elective admissions for PD patients were identified using ICD-10 codes. Where G20X or F02.3 codes were secondary diagnoses, the ICD-10 codes listed as primary diagnosis were examined. Individual ICD-10 codes were grouped into larger sub-categories and stratified according to whether they were PD-related or not, based on the consensus opinion of two clinicians (CEC and RW). These were compared with data from the corresponding control group. Admission cost and EBD cost for each sub-category were calculated excluding the 'other' sub-category for controls, which proved impractical to calculate given the large numbers.

Statistical analysis

We present crude and age- and sex-specific descriptive statistics for PD and control groups for all admissions and specific diagnostic groups. Ideally, one would then test if certain conditions are more likely to result in a higher hospitalisation rate for PD patients than controls by calculating the relative admission rate. However, the HES

database only contains admission data; it does not provide population denominators. Though census data can be used for the control populations, there is no equivalent data for PD patients and extrapolating from localised cross-sectional studies may be problematic, under-estimating the true population denominator, thereby inflating the PD rate. Therefore, we examined the proportion of admissions for a specific cause compared to all admissions for PD cases and controls. Age and sex were taken into account, as PD is more common in men and the prevalence increases with age. Firstly, we present the PD and control data stratified by age groups and sex allowing comparison of age- and sex-specific proportions. Secondly, we used indirect standardisation, with proportions in the control population being the standard, so that we derived proportional ratios for cause-specific admissions and mortality analogous to standardised admission and mortality rates.[10] A ratio >1 indicates a greater proportion and a value <1 indicates a lower proportion. From this, we calculated the age- and sex-adjusted admission rate per 100 admissions. Finally, we used Poisson regression models using the count of condition-specific admissions as the outcome, all admissions as the denominator and an indicator variable for the PD versus control groups. We then adjusted for age group and sex in the multivariable models by using these as covariates. For LOS, we calculated the mean length for descriptive purposes but, because of data skewness, we only formally tested for differences by comparing the proportion with a LOS greater than three months (excessive stay) in the PD group with controls as above.

RESULTS

Between 1st April 2009 and 31st March 2013, there were 65,778,094 elective and non-elective admissions recorded in HES (Supplementary Figure). Admissions

'under 35' years of age, 'unknown' age or 'unknown or unspecified sex' were omitted leading to 15,903,994 (24.2%) admissions being excluded. Of the remaining 49,874,100 admissions, 324,055 were generated by 182,859 PD patients (0.69%) and 49,550,045 by 26,419,116 controls almost three times the crude expected proportion over 35 years (0.24%) from two recent prevalence studies.[11,12] The numbers excluded for reasons other than age <35 years accounted for less than 0.5% of the total cohort (0.2% of the PD group had missing covariates). 28% and 72% of PD admissions were elective and non-elective respectively compared to 60% and 40% in controls.

Table 1 provides admission count and cost of admissions stratified by sex and age of elective and non-elective admissions for PD patients. Approximately 60% of the admissions were generated by male patients reflecting the higher male prevalence of PD. More admissions occurred in age groups above 65 years of age, with almost half of the admissions occurring in 75 to 84 year olds.

The total cost of PD admissions over 4 years was £906,617,908. The cost per admission increased with increasing age, with the oldest age bracket (>85 year old) costing the most per admission (Table 1). Whilst the proportion of non-elective admissions was 72%, the cost was disproportionately higher with non-elective admissions resulting in 86% (£777,476,489) of the total cost. The average cost per admission reflected this with elective and non-elective admissions costing £1,417 and £3,338 per admission, respectively. There were no differences in cost per admission between male and female patients.

After excluding ZBD admissions, the number of non-elective PD admissions was 204,266 costing £716,606,754 (Table 2). Twelve percent of the total cost consisted of EBD costs, incurred due to exceptionally long inpatient stays. The largest category was 'other' (36.5%), consisting of over 100 ICD-10 codes recorded as a primary diagnosis, but appearing at low frequencies. Thereafter, the most common reasons for non-elective admissions probably related to PD were pneumonia (13.5%), "PD" itself (9.4%), urinary tract infection (UTI; 9.2%), and hip fractures (4.3%). Of these, "PD" and hip fracture incurred a higher percentage of the total costs (12% and 7.6% respectively) compared to the frequency in which they occurred in relation to the total number of admissions. In controls, the proportion of the non-elective admissions for pneumonia, UTI and hip fractures of the total were 7%, 2.9% and 1.6% respectively (Supplementary Table 1), indicating that these conditions were over-represented in patients with PD with unscheduled admissions.

The relative proportions for non-elective admissions between the PD and control groups are shown in Supplementary Table 3 for UTI, pneumonia, hip fracture, and other fracture. Age and sex-standardised risk and proportional admission ratio have been calculated for each condition (Supplementary Tables 2 and 3). The relative proportion of admissions for each of these conditions is substantially higher for each condition, especially UTI (ratio 2.63, 95% CI 2.59, 2.67, $p<0.0001$) with an age and sex standardised risk of 6 per 100 admissions. Pneumonia admissions were more common at 8.4 per 100 admissions, but the ratio was less elevated (ratio 1.55, 95% CI 1.53, 1.57, $p<0.0001$) compared to controls.

Figure 1 shows that mean LOS for non-elective admissions was consistently longer in PD patients than controls for both sexes and across all age groups. Mean LOS for PD patients was seven days longer than controls (16 versus 9 days). There was a trend for increasing mean LOS with increasing age in the PD group which was not mirrored in the control group. For the PD group, average LOS between the two sexes were comparable, apart from the '35 – 44' year old where LOS for males was longer than females. PD patients were almost twice as likely to have admissions resulting in LOS greater than three months (ratio 1.90, 95% CI 1.83, 1.97, p<0.0001). Mean LOS was longer in PD patients than controls for UTI, pneumonia, hip fracture, and other fractures (Supplementary Table 4).

Mortality was increased in PD patients compared with controls (Supplementary Table 5) with a proportional mortality ratio of 2.46 (95%CI 2.42, 2.49, p<0.0001). The increase was particularly marked for those over 85 years, with around 10% of PD admissions resulting in death.

DISCUSSION

To our knowledge, this is the first study to provide precise national costs of PD admissions. Over a 4 year period, there were 324,055 PD admissions at a total cost of over £907 million. The vast majority (72%) were non-elective at a cost of £777 million over 4 years or, on an annual basis, 58,226 admissions costing £194 million. Previous studies estimated all aspects of direct healthcare costs in comparison to the present study which examined hospital costs only. The 1998 UK Global PD Survey (UKGPDS) estimated the annual direct healthcare costs in 432 PD patients to be £5,993 per person which suggested a total annual spend on PD of around

£600 million at that time.[13] With such large sums, even small reductions in the numbers of non-elective admissions would lead to significant savings.

As expected, the admission count and cost per admission increased with age to around £3,200 per admission in those over 85 years. Increased co-morbidity in this age group may have led to more 'problems' being coded which would increase costs. Total annual direct healthcare costs also increased with age in the UKGPDS, from £3,978 per person less than 65 years to £9,393 per person over 85 years.[13] So, interventions focussed on older PD patients should have more financial impact.

Mean LOS for non-elective admissions was seven days longer in PD patients than controls. The annual cost of EBDs, relating to exceptionally long inpatient stays, for PD emergency admissions was over £22 million highlighting the potential for cost savings. Gerlach and colleagues systematic review of PD hospitalisation studies found that most previous studies had shown increased LOS in PD.[14]

Most concerning of all is the excess mortality in admitted PD patients compared to controls, particularly for those over 85 years, with 10% of PD admissions resulting in death. This is consistent with a previous review of case-control and cohort studies showing an excess mortality ratio in PD of 2.56 (95% CI 2.46, 2.66, $p<0.00001$).[15] It has been shown that more than 50% of people with PD die in hospital, with nearly a third dying in care homes and a much smaller percentage dying at home.[16] This calls for improved advance care planning for PD patients with advanced disease.

The most frequent reasons for non-elective admissions in our national sample were pneumonia (13.5%), advanced “PD” (9.4%), UTI (9.2%), and hip fractures (4.3%). This is in line with previous reports from individual institutions,[2-6] although the precise proportions differ, probably due to differences in coding. We have also shown that UTI, pneumonia, hip fractures and other fractures occur more frequently in PD than in age and sex matched controls, with proportional admission ratios from 1.5 to 2.6 times the control group. Several previous studies have shown an increased fracture rate in PD. In a study using the UK General Practice Research Database, the risks of any fracture and hip fracture were almost doubled and tripled for PD patients (adjusted hazard ratio any fracture 1.89, 95% CI; 1.67, 2.14; risk of hip fracture 3.08; 95%, CI 2.43, 3.89).[17] Similarly, using the UK National Hip Fracture Database, the relative risk of hip fracture for those aged over 60 years was 3.7 (95% CI 2.6, 5.3) for PD patients in Northumbria Healthcare NHS Foundation Trust in the UK.[18] Imbalance and falls are common in PD and poorly responsive to dopaminergic medication. Osteoporosis is common in PD in view of age and immobility,[19] so the increased risk of fracture is not surprising. Some of the increase of UTI may be due to over-diagnosis of UTI, but bladder function is affected in PD.[20] Pneumonia is due to a combination of deteriorating motor function and PD-related dysphagia and is a common cause of death.[21] It would seem appropriate to focus interventions to reduce admissions on these most common causes.

The key issue is to what degree could these admissions, the resulting costs and mortality be avoided by better care? We have summarised some potential interventions which may reduce and better manage PD non-elective admissions in

Table 3.[3, 19, 22-29] The evidence base for some of these interventions is speculative and such processes will require careful evaluation before we can assume they are cost-effective. Healthcare systems already address some of these issues, but we suspect in an ad hoc manner rather than using a systematic approach. Different models of healthcare should be considered. For example, PD Nurse Specialists could lead an integrated community and secondary care team, combining the skills of primary care, hospital specialists, rehabilitation specialists, other allied healthcare specialties, and palliative care.

This is the largest study of its kind with real-world direct healthcare costs on which reimbursement is based in England. Its main limitation is the reliance on routinely coded data with the potential for errors in both coding and costing. However, a recent systematic review noted that coding accuracy rates were improving and sufficiently robust for both research and managerial decision making.[30] An ongoing study examining electronic prescribing records in PD, in addition to the local ICD-10 returns, at Queen Elizabeth Hospital, Birmingham, UK suggests that ICD-10 returns miss over 15% of PD admissions (CEC personal communication). These data would suggest we may have under-estimated the size of the problem. We had to calculate the proportional risk ratios rather than ratios based on the true PD population at risk. This is unlikely to have biased our hospital-based mortality ratios or excessive lengths of stay but may have inflated the ratios for urinary tract infections, as PD patients are less likely to be admitted with smoking-related morbidity[31] and hence other admission causes, if unrelated to smoking, would appear relatively more important. However, as smoking predicts fracture risk,[32] then our observed estimates for fractures are likely to be an under-estimate.

In conclusion, the NHS spends nearly £200 million per year on emergency admissions in PD patients. The main reasons for admission are pneumonia, motor decline, UTI, and hip fractures which occur more frequently in PD than in a control group. PD patients have longer hospital stays and are 2.5 times more likely to die. Urgent attention should be given to developing interventions to reduce the burden of hospitalisation in PD for patients, their carers and healthcare systems.

Acknowledgements

The authors would like to thank Shahadat Uddin and Rebeka Morley from Health IQ for managing and extracting the required data.

Contributors

V. Low: research project: organisation, and execution; statistical analysis: review and critique; manuscript: writing of the first draft, review and critique.

Y. Ben-Shlomo: research project: organisation, and execution; statistical analysis: performance, review and critique; manuscript: review and critique.

E. Coward: research project: organisation, and execution; manuscript: review and critique.

S. Fletcher: research project: organisation, and execution; manuscript: review and critique.

R. Walker: research project: organisation, and execution; review and critique; manuscript: review and critique.

C.E. Clarke: research project: conception, organisation, and execution; review and critique; manuscript: writing of the first draft, review and critique.

Funding

UCB provided funding to obtain the relevant HES data from HealthIQ.

Competing interests

C. E. Clarke: Advisory Boards: AbbVie, Britannia, Lundbeck, Teva, UCB; Honoraria: AbbVie, Britannia, Lundbeck, Teva, UCB; Educational grants: AbbVie, Britannia, GE Healthcare, Lundbeck, Medtronic, Teva.

R.W. Walker: Advisory Boards: AbbVie, Britannia, Teva; Honoraria: GSK, Lundbeck, Teva, UCB.

V. Low, E. Coward & S. Fletcher are employees of UCB Pharma Ltd.

Ethical approval

Not required.

References

[1] Dorsey ER, Constantinescu R, Thompson JP, Biglan KM, Holloway RG, Kieburtz K, et al. Projected number of people with Parkinson disease in the most populous nations, 2005 through 2030. Neurology. 2007;68:384-6.

[2] Arasalingam A, Clarke CE. Reasons for Parkinson's disease admissions in a large inner city hospital. Parkinsonism Relat Disord. 2014;20:237-8.

[3] Klein C, Prokhorov T, Miniovitz A, Dobronevsky E, Rabey J. Admission of Parkinsonian patients to a neurological ward in a community hospital. J Neural Transm. 2009;116:1509-12.

[4] Temlett JA, Thompson PD. Reasons for admission to hospital for Parkinson's disease. Intern Med J. 2006;36:524-6.

[5] Vossius C, Nilsen OB, Larsen JP. Parkinson's disease and hospital admissions: frequencies, diagnoses and costs. Acta Neurol Scand. 2010;121:38-43.

[6] Woodford H, Walker R. Emergency hospital admissions in idiopathic Parkinson's disease. Mov Disord. 2005;20:1104-8.

[7] Lubomski M, Rushworth RL, Tisch S. Hospitalisation and comorbidities in Parkinson's disease: a large Australian retrospective study. J Neurol Neurosurg Psychiatry. 2014.

[8] Guttman M, Slaughter PM, Theriault ME, DeBoer DP, Naylor CD. Burden of parkinsonism: a population-based study. Mov Disord. 2003;18:313-9.

[9] Health and social care information centre. Hospital episodes statistics. 2014.

[10] Rothman K, Greenland S. Modern Epidemiology. Second ed. Philadelphia: Lippincott-Raven; 1998.

[11] Porter B, Macfarlane R, Unwin N, Walker R. The prevalence of Parkinson's disease in an area of North Tyneside in the north-east of England. Neuroepidemiology 2006;26:156–161.

[12] Wickremaratchi MM, Perera D, O'Loghlen Carl, Sastry D, Morgan E, Jones A, Edwards P, Robertson NP, Butler C, Morris HR, Ben-Shlomo Y. Prevalence and age of onset of Parkinson's disease in Cardiff: a community based cross sectional study and meta-analysis. J Neurol Neurosurg Psychiatry 2009;80:805–807.

[13] Findley L, Aujla M, Bain PG, Baker M, Beech C, Bowman C, et al. Direct economic impact of Parkinson's disease: a research survey in the United Kingdom. Mov Disord. 2003;18:1139-45.

[14] Gerlach OH, Winogrodzka A, Weber WE. Clinical problems in the hospitalized Parkinson's disease patient: systematic review. Mov Disord. 2011;26:197-208.

[15] Clarke CE. Has drug therapy changed the natural history of Parkinson's disease? J Neurol. 2010;257:S262-7.

[16] Snell K, Pennington S, Lee M, Walker R. The place of death in Parkinson's disease. Age Ageing. 2009;38:617-9.

[17] Pouwels S, Bazelier MT, de Boer A, Weber WE, Neef C, Cooper C, et al. Risk of fracture in patients with Parkinson's disease. Osteoporos Int. 2013;24:2283-90.

[18] Walker RW, Chaplin A, Hancock RL, Rutherford R, Gray WK. Hip fractures in people with idiopathic Parkinson's disease: incidence and outcomes. Mov Disord. 2013;28:334-40.

[19] van den Bos F, Speelman AD, Samson M, Munneke M, Bloem BR, Verhaar HJ. Parkinson's disease and osteoporosis. Age Ageing. 2013;42:156-62.

[20] Blackett H, Walker R, Wood B. Urinary dysfunction in Parkinson's disease: a review. Parkinsonism Relat Disord. 2009;15:81-7.

[21] Pennington S, Snell K, Lee M, Walker R. The cause of death in idiopathic Parkinson's disease. Parkinsonism Relat Disord. 2010;16:434-7.

[22] Huntley A, Lasserson D, Wye L, Morris R, Checkland K, England H, et al. Which features of primary care affect unscheduled secondary care use? A systematic review. BMJ Open. 2014;4:e004746.

[23] Jarman B, Hurwitz B, Cook A. Parkinson's Disease Nurse Specialists in primary care: a randomised controlled trial. Mov Disord. 2000;15 (suppl 3):178.
[24] Tomlinson CL, Patel S, Meek C, Herd CP, Clarke CE, Stowe R, et al. Physiotherapy versus placebo or no intervention in Parkinson's disease. Cochrane Database Syst Rev. 2013;9:CD002817.
[25] Rolinski M, Fox C, Maidment I, McShane R. Cholinesterase inhibitors for dementia with Lewy bodies, Parkinson's disease dementia and cognitive impairment in Parkinson's disease. Cochrane Database Syst Rev. 2012;3:CD006504.
[26] Herd CP, Tomlinson CL, Deane KH, Brady MC, Smith CH, Sackley CM, et al. Speech and language therapy versus placebo or no intervention for speech problems in Parkinson's disease. Cochrane Database Syst Rev. 2012;8:CD002812.
[27] Barber ND, Alldred DP, Raynor DK, Dickinson R, Garfield S, Jesson B, et al. Care homes' use of medicines study: prevalence, causes and potential harm of medication errors in care homes for older people. Qual Saf Health Care. 2009;18:341-6.
[28] National Council for Palliative Care. The end of life care strategy: new ambitions. London. 2014.
[29] Skelly R, Brown L, Fakis A, Kimber L, Downes C, Lindop F, et al. Does a specialised unit improve outcomes for hospitalised patients with Parkinson's disease. Parkinsonism and Related Disorders. 2014.
[30] Burns EM, Rigby E, Mamidanna R, Bottle A, Aylin P, Ziprin P, et al. Systematic review of discharge coding accuracy. J Public Health (Oxf). 2012;34:138-48.
[31] Hernan MA, Takkouche B, Caamano-Isorna F, Gestal-Otero JJ. A meta-analysis of coffee drinking, cigarette smoking, and the risk of Parkinson's disease. Ann Neurol. 2002;52:276-84.
[32] Law MR, Hackshaw AK. A meta-analysis of cigarette smoking, bone mineral density and risk of hip fracture: recognition of a major effect. BMJ. 1997;315:841-6.

Figure Legend

Fig 1 Mean length of stay for non-elective admissions for Parkinson's disease and controls (days) excluding ZBDs

TABLE 1 Admissions and costs for Parkinson's disease patients by age and gender(2009 –2013)*

PD Group								
	Male				Female			
Age	Admission count	% of total admissions	Total cost of admissions (£)	Cost per admission (£)	Admission count	% of total admissions	Total cost of admissions (£)	Cost per admission (£)
35 – 44 yrs	651	0.3%	1,236,071	1,899	418	0.3%	792,248	1,895
45 – 54 yrs	3,473	1.8%	6,943,726	1,999	1,774	1.4%	3,401,409	1,917
55 – 64 yrs	15,658	8.1%	33,014,414	2,108	8,270	6.4%	17,514,879	2,118
65 – 74 yrs	49,433	25.5%	120,844,023	2,445	28,838	22.2%	72,340,404	2,509
75 – 84 yrs	87,875	45.3%	251,842,998	2,866	57,855	44.5%	173,343,960	2,996
> 85 yrs	36,951	19.0%	117,789,799	3,188	32,859	25.3%	107,553,977	3,273
Total	194,041	100%	531,671,031	2,740	130,014	100%	374,946,877	2,884

* Patients under 35 yrs/'unknown age'/'unknown sex'/'unspecified sex' were excluded. Together they comprised of less than 0.2% of the total PD admissions

TABLE 2 Reasons for non-elective admissions in PD group excluding ZBDs

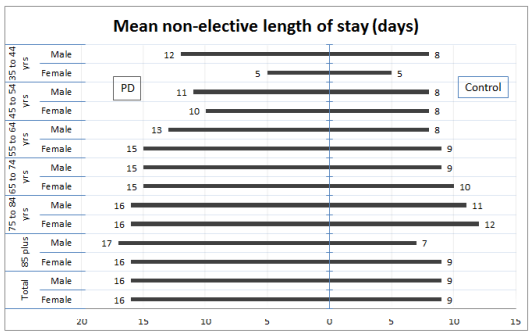
Categories	Relation to PD	Sub-categories	Non-elective admissions	Admissions cost (£)	Excess bed day cost (£)
Parkinson's Disease	Probably related	PD*	19,152	85,621,216	15,188,136
		Dementia in PD*	230	110,657	45,066
Infections		UTI	18,808	68,253,387	5,011,783
		Pneumonia	27,604	96,232,522	11,176,138
		Septicaemia	1,500	5,427,265	469,479
		Cellulitis	2,132	6,363,726	477,746
Neuropsychiatric disorders		Senility	5,465	18,495,257	1,093,041
		Disorientation	2,027	6,139,024	511,481
		Delirium	622	513,146	218,947
		Hallucinations	386	54,555	10,108
Problems relating to blood pressure		Syncope & collapse	4,171	8,577,066	805,168
		Orthostatic hypotension	2,837	7,318,668	1,926,982
		Hypotension	399	975,855	266,833
		Acute renal failure	1,896	7,615,428	532,087
		Volume depletion	1,158	3,750,754	200,602
Falls & fractures		Fracture neck of femur	8,775	54,707,957	2,997,913
		Head injuries	2,481	6,786,975	945,367
		Other fractures	2,915	10,784,935	1,826,409
Gastrointestinal disorders		Constipation	2,428	6,680,518	507,324
		Dysphagia	573	2,092,859	463,742
	Unlikely to be related	Gastroenteritis	2,605	8,709,427	1,323,900
		Nausea & vomiting	634	1,573,621	90,390
Cardiovascular disorders		Cardiac-related	12,346	30,462,506	2,805,118
		Stroke	3,849	19,041,318	1,397,597
		TIA	1,359	3,487,616	573,848
Genitourinary & renal disorders		Urinary retention	1,375	3,532,354	276,553
		Complications with catheter	834	2,012,693	177,961
		Haematuria	1,080	2,616,326	194,121
Other		(All other admissions)	74,625	248,669,123	35,411,129
Total			204,266	716,606,754	86,924,969

*Recorded as the primary diagnoses

TABLE 3 Potential interventions to avoid or better manage hospitalisation for PD

Condition	Intervention	Evidence base
Prevention of admission& re-admission		
All	Open access to PD nurse service	RCT[3,23]
	Open access to PD clinic	Evidence required
	Better access to identified general practitioner	Systematic review[22]
	Carer support	Evidence required
	Improvement in the process of medicine administration in care homes and better communication between care homes and medical personnel (GPs and pharmacists)	Ethnographic study[27]
Motor decline	Medication optimization (if possible)	Observational evidence
	Physiotherapy and occupational therapy assessment and possibly treatment	Systematic review[24]
Falls and fractures	Osteoporosis screening and management	Systematic review[19]
Dementia, psychosis	Psychiatric assessment, anti-parkinsonian drug reduction, cholinesterase inhibitors	Systematic review[25]
Palliative care	Consider end-of-life issues	Observational evidence[28]
Improved management of admission		
All	Rapid access to rehabilitation team including physiotherapy, occupational therapy and speech and language therapy	Systematic reviews[24,26]
	Access to specialist PD ward	Observational evidence[29]
	Adequate management for PD patients undergoing surgery	Evidence required
	Alert system to trigger review all PD inpatients by specialist PD team	Evidence required
	Improved access to PD medication in hospitals, especially out-of-hours	Evidence required

	Swallow assessment and appropriate medicine use in patients with swallowing difficulties	Evidence required
	Ensure adequate hydration	Evidence required
	Nurse and junior doctor training on the need for PD medication administration on time	Evidence required
	Patient/carer education and empowerment on ensuring that medications are conveyed accurately to ward staff together with dose intervals and enquiring on possibility of self-medicating	Evidence required



We examined hospitalisation in Parkinson's disease using English Hospital Episodes Statistics.

There were 324,055 Parkinson's disease admissions in 182,859 patients over 4 years.

This included 232,905 non-elective admissions which cost £777 million.

Pneumonia, urinary tract infection and hip fracture occurred 1.5-2.6 times more in patients than controls.

Patients were twice as likely to stay in hospital over 3 months and even more likely die in hospital.

SUPPLEMENTARY TABLE 1 Reasons for non-elective admissions in the control group excluding ZBDs

Categories	Sub-categories	Non-elective admissions	Admissions cost (£)	Excess bed day cost (£)
Infections	UTI	457,040	1,308,878,706	86,540,940
	Pneumonia	1,089,265	3,070,321,597	223,970,243
	Septicaemia	69,394	212,360,406	13,805,181
	Cellulitis	148,901	360,375,335	26,849,127
Neuropsychiatric disorders	Senility	95,260	283,787,111	17,654,524
	Disorientation	58,183	145,864,809	16,641,607
	Delirium	15,340	7,672,104	2,172,521
	Hallucinations	2,183	297,864	61,139
Problems relating to blood pressure	Syncope & collapse	183,168	275,767,500	21,252,055
	Orthostatic hypotension	45,931	84,167,001	13,946,523
	Hypotension	10,271	19,179,036	3,180,752
	Acute renal failure	109,491	381,964,643	23,575,006
	Volume depletion	29,194	78,321,892	4,346,054
Falls & fractures	Fracture neck of femur	252,059	1,486,141,293	46,531,692
	Head injuries	95,963	156,150,784	23,240,964
	Other fractures	163,258	479,608,842	47,833,068
Gastrointestinal disorders	Constipation	90,247	201,767,574	8,612,370
	Dysphagia	15,063	40,896,900	5,152,693
	Gastroenteritis	171,988	387,719,186	34,906,804
	Nausea & vomiting	58,531	103,814,381	4,579,029
Cardiovascular disorders	Cardiac-related	1,286,168	2,505,795,648	149,445,919
	Stroke	272,006	1,222,495,198	117,306,878
	TIA	72,192	122,932,368	10,699,797
Genitourinary & renal disorders	Urinary retention	60,585	108,545,215	6,352,785
	Complications with catheter	18,850	35,439,361	1,977,765
	Haematuria	46,186	80,767,214	4,782,350
Other	(All other admissions)	10,751,808	*	*
Total		15,668,525		

SUPPLEMENTARY TABLE 2 Non-elective admission count between PD and control group for UTI, pneumonia, hip fractures and other fractures excluding ZBDs

Gender	Age	PD	Control	Gender	Age	PD	Control
UTI				Hip fractures			
Male	35 – 44 yrs	7	4,664	Male	35 – 44 yrs	1	1,422
	45 – 54 yrs	43	8,442		45 – 54 yrs	8	2,680
	55 – 64 yrs	340	15,391		55 – 64 yrs	100	5,228
	65 – 74 yrs	1,933	30,379		65 – 74 yrs	630	9,783
	75 – 84 yrs	5,415	59,136		75 – 84 yrs	1960	22,643
	> 85 yrs	2,891	60,933		> 85 yrs	1113	25,132
Female	35 – 44 yrs	11	12,034	Female	35 – 44 yrs	2	591
	45 – 54 yrs	33	14,022		45 – 54 yrs	4	2,394
	55 – 64 yrs	206	17,562		55 – 64 yrs	94	7,636
	65 – 74 yrs	1,119	32,000		65 – 74 yrs	786	19,961
	75 – 84 yrs	3,967	80,087		75 – 84 yrs	2526	63,222
	> 85 yrs	2,843	122,390		> 85 yrs	1551	91,367
Pneumonia				Other fractures			
Male	35 – 44 yrs	9	18,531	Male	35 – 44 yrs	0	7,517
	45 – 54 yrs	78	32,055		45 – 54 yrs	10	8,470
	55 – 64 yrs	582	65,436		55 – 64 yrs	44	7,723
	65 – 74 yrs	3024	119,786		65 – 74 yrs	193	6,865
	75 – 84 yrs	8897	168,447		75 – 84 yrs	450	7,583
	> 85 yrs	5704	136,378		> 85 yrs	197	6,709
Female	35 – 44 yrs	19	18,373	Female	35 – 44 yrs	2	4,836
	45 – 54 yrs	29	30,618		45 – 54 yrs	2	8,299
	55 – 64 yrs	260	59,256		55 – 64 yrs	70	15,057
	65 – 74 yrs	1330	99,519		65 – 74 yrs	410	19,263
	75 – 84 yrs	4091	158,531		75 – 84 yrs	996	33,902
	> 85 yrs	3581	182,335		> 85 yrs	541	37,034

SUPPLEMENTARY TABLE 3 Comparison of non-elective admissions between Parkinson's disease and control groups for UTI, pneumonia, hip fractures and other fractures excluding ZBDs

Gender	Age	PD (%)	Control (%)	Relative proportions	Gender	Age	PD (%)	Control (%)	Relative proportions
UTI					Hip fractures				
Male	35 – 44 yrs	1.97	0.49	4.0	Male	35 – 44 yrs	0.28	0.15	1.9
	45 – 54 yrs	2.40	0.74	3.2		45 – 54 yrs	0.45	0.24	1.9
	55 – 64 yrs	4.24	1.19	3.6		55 – 64 yrs	1.25	0.41	3.0
	65 – 74 yrs	6.48	2.00	3.2		65 – 74 yrs	2.11	0.64	3.3
	75 – 84 yrs	8.35	3.58	2.3		75 – 84 yrs	3.02	1.37	2.2
	> 85 yrs	9.19	2.12	4.3		> 85 yrs	3.54	0.88	4.0
Female	35 – 44 yrs	4.80	0.62	7.7	Female	35 – 44 yrs	0.87	0.03	29.0
	45 – 54 yrs	4.18	1.34	3.1		45 – 54 yrs	0.51	0.23	2.2
	55 – 64 yrs	5.07	1.68	3.0		55 – 64 yrs	2.31	0.73	3.2
	65 – 74 yrs	6.40	2.45	2.6		65 – 74 yrs	4.50	1.53	2.9
	75 – 84 yrs	8.85	4.29	2.1		75 – 84 yrs	5.64	3.38	1.7
	> 85 yrs	9.73	3.52	2.8		> 85 yrs	5.31	2.63	2.0
Age and sex standardised risk - 6.0 per 100 admissions (95% CI 5.9, 6.1); proportional admission ratio – 2.63 (95% CI 2.59, 2.67, p<0.0001)					Age and sex standardised risk - 2.8 per 100 admission (95% CI 2.7, 2.8); proportional admission ratio – 2.21 (95% CI 2.16, 2.25, p<0.0001)				
Pneumonia					Other fractures				
Male	35 – 44 yrs	2.53	1.97	1.3	Male	35 – 44 yrs	0.00	0.80	0.0
	45 – 54 yrs	4.36	2.82	1.5		45 – 54 yrs	0.56	0.74	0.8
	55 – 64 yrs	7.25	5.08	1.4		55 – 64 yrs	0.55	0.60	0.9
	65 – 74 yrs	10.14	7.89	1.3		65 – 74 yrs	0.65	0.45	1.4
	75 – 84 yrs	13.72	10.19	1.3		75 – 84 yrs	0.69	0.46	1.5
	> 85 yrs	18.13	4.75	3.8		> 85 yrs	0.63	0.23	2.7
Female	35 – 44 yrs	8.30	0.95	8.7	Female	35 – 44 yrs	0.87	0.25	3.5
	45 – 54 yrs	3.68	2.94	1.3		45 – 54 yrs	0.25	0.80	0.3
	55 – 64 yrs	6.40	5.67	1.1		55 – 64 yrs	1.72	1.44	1.2
	65 – 74 yrs	7.61	7.61	1.0		65 – 74 yrs	2.35	1.47	1.6
	75 – 84 yrs	9.13	8.48	1.1		75 – 84 yrs	2.22	1.81	1.2

	> 85 yrs	12.26	5.24	2.3		> 85 yrs	1.85	1.07	1.7
Age and sex standardised risk - 8.4 per 100 admission (95% CI 8.3, 8.5); proportional admission ratio - 1.55 (95% CI 1.53, 1.57, p<0.0001)					Age and sex standardised risk - 1.2 per 100 admission (95% CI 1.1, 1.2); proportional admission ratio - 1.45 (95% CI 1.39, 1.50, p<0.0001)				

SUPPLEMENTARY TABLE 4 Comparison of mean length of stay for non-elective admissions between PD and control group for UTI, pneumonia, hip fractures and other fractures excluding ZBDs

Gender	Age	PD (Days)	Control (Days)	Gender	Age	PD (Days)	Control (Days)
UTI				Hip fractures			
Male	35 – 44 yrs	6	5	Male	35 – 44 yrs	12	10
	45 – 54 yrs	9	6		45 – 54 yrs	7	12
	55 – 64 yrs	11	7		55 – 64 yrs	22	15
	65 – 74 yrs	15	8		65 – 74 yrs	25	18
	75 – 84 yrs	16	11		75 – 84 yrs	29	22
	> 85 yrs	17	13		> 85 yrs	28	24
Female	35 – 44 yrs	8	4	Female	35 – 44 yrs	5	10
	45 – 54 yrs	8	5		45 – 54 yrs	40	11
	55 – 64 yrs	11	7		55 – 64 yrs	20	13
	65 – 74 yrs	14	9		65 – 74 yrs	24	16
	75 – 84 yrs	16	12		75 – 84 yrs	26	20
	> 85 yrs	16	14		> 85 yrs	26	23
Pneumonia				Other fractures			
Male	35 – 44 yrs	10	6	Male	35 – 44 yrs	0	4
	45 – 54 yrs	13	7		45 – 54 yrs	18	5
	55 – 64 yrs	14	8		55 – 64 yrs	15	6
	65 – 74 yrs	15	9		65 – 74 yrs	18	8
	75 – 84 yrs	16	11		75 – 84 yrs	19	13
	> 85 yrs	17	13		> 85 yrs	19	16
Female	35 – 44 yrs	6	6	Female	35 – 44 yrs	4	4
	45 – 54 yrs	21	6		45 – 54 yrs	7	4
	55 – 64 yrs	14	7		55 – 64 yrs	10	4
	65 – 74 yrs	15	9		65 – 74 yrs	13	6
	75 – 84 yrs	15	12		75 – 84 yrs	18	12
	> 85 yrs	16	13		> 85 yrs	19	16

SUPPLEMENTARY TABLE 5 Deaths during admissions*

Gender	Age	PD			Control			Relative proportions
		Died	Total admissions	Proportion (%)	Died	Total admissions	proportion (%)	
Male	35 – 44 yrs	1	650	0.2	6,576	2,407,032	0.3	0.7
	45 – 54 yrs	30	3,463	0.9	16,331	3,334,200	0.5	1.8
	55 – 64 yrs	266	15,585	1.7	40,313	4,463,862	0.9	1.9
	65 – 74 yrs	1,986	49,144	4.0	81,834	5,345,948	1.5	2.7
	75 – 84 yrs	6,749	87,232	7.7	141,343	4,561,930	3.1	2.5
	> 85 yrs	4,454	36,624	12.2	130,592	3,691,986	3.5	3.5
	Total	13,486	192,698	7.0	416,989	23,804,958	1.8	3.9
Female	35 – 44 yrs	7	418	1.7	5,590	4,002,933	0.1	17.0
	45 – 54 yrs	15	1,766	0.8	13,533	3,883,641	0.3	2.7
	55 – 64 yrs	133	8,220	1.6	30,387	4,236,542	0.7	2.3
	65 – 74 yrs	806	28,641	2.8	60,118	4,735,830	1.3	2.2
	75 – 84 yrs	3,308	57,364	5.8	132,721	4,461,605	3	1.9
	> 85 yrs	3,190	32,559	9.8	195,904	4,303,665	4.6	2.1
	Total	7,459	128,968	5.8	438,253	25,624,216	1.7	3.4
Age and sex adjusted mortality risk 4.3 per 100 admissions (95% CI 4.2, 4.3); Proportional mortality ratio - 2.46 (95%CI 2.42, 2.49, p<0.0001)								

* Only admissions and deaths occurring within the 4 year study period are included