Published in final edited form as:

J Parkinsons Dis. 2016 April 2; 6(2): 383–392. doi:10.3233/JPD-150765.

Development and validation of the Parkinson's Disease Medication Beliefs Scale (PD-Rx)

JE Fleisher^a, NA Dahodwala^b, SX Xie^c, M Mayo^b, D Weintraub^b, J Chodosh^d, and JA Shea^e

^aNew York University School of Medicine, Departments of Neurology and Population Health. 240 E. 38th Street, 20th Floor, New York, NY, 10016, USA.

^bUniversity of Pennsylvania Perelman School of Medicine, Department of Neurology, 330 S. 9th Street, 3rd Floor, Philadelphia, Pennsylvania, 19107 USA.

^cUniversity of Pennsylvania Perelman School of Medicine, Department of Biostatistics and Epidemiology. 607 Blockley Hall, 423 Guardian Drive, Philadelphia, Pennsylvania, 19104, USA.

^dNew York University School of Medicine, Division of Geriatric Medicine and Palliative Care, Department of Medicine. 550 1st Avenue BCD 616, New York, New York, 10016, USA.

^eUniversity of Pennsylvania Perelman School of Medicine, Department of Medicine. 1229 Blockley Hall, 423 Guardian Drive, Philadelphia, Pennsylvania, 19104.

Abstract

BACKGROUND—Medication non-adherence is common in Parkinson's disease (PD) and is associated with increased disability and healthcare costs. Individuals' beliefs regarding their medical conditions and treatments impact medication adherence. While instruments exist to measure patients' beliefs about medications in general, no such tool exists for PD.

Corresponding author at: Jori Fleisher, MD MSCE, 240 E. 38th Street, 20th Floor, New York, NY 10016; Phone: (646) 501-9259; Fax: (212) 263-7721; ; Email: Jori.Fleisher@nyumc.org
Dahodwan@mail.med.upenn.edu, Sxie@mail.med.upenn.edu, Joshua.Chodosh@nyumc.org, Sheaja@mail.med.upenn.edu

Authorship:

- JE Fleisher: Conception and design of study, acquisition of data, analysis and interpretation of data; drafting and revision of manuscript; final approval of manuscript
- NA Dahodwala: Conception and design of study, analysis and interpretation of data; drafting and revision of manuscript; final approval of manuscript
- M Mayo: Acquisition and analysis of data; revision of manuscript; final approval of manuscript
- SX Xie: Conception and design of study, analysis and interpretation of data; drafting and revision of manuscript; final approval of manuscript
- D Weintraub: Interpretation of data; revision of manuscript; final approval of manuscript
- J Chodosh: Interpretation of data; revision of manuscript; final approval of manuscript
- JA Shea: Conception and design of study, analysis and interpretation of data; drafting and revision of manuscript; final approval of manuscript

Conflict of Interest: The authors have no conflict of interest to report.

Supplementary Material:

Additional details on the conduct of focus groups, expert review, and instrument development are provided for reproducibility.

OBJECTIVES—Create an instrument eliciting medication beliefs of persons with PD; identify demographic and clinical characteristics associated with beliefs; and examine whether beliefs are associated with dopaminergic therapy adherence.

METHODS—We developed the Parkinson's Disease Medication Beliefs Scale (PD-Rx) in four phases: focus groups of patients and caregivers to generate items, scale development, expert and patient revision of items, and a cross-sectional validation sample (n=75). Adherence was calculated using two approaches incorporating self-reported medication lists.

RESULTS—The PD-Rx consists of 11 items covering benefits and risks of PD pharmacotherapies. The scale covers motor improvement, current adverse effects, and future concerns. Higher scores indicate more positive beliefs. Internal consistency was acceptable (Cronbach's alpha=0.67). Test-retest reliability was 0.47. Quality of life was associated with PD-Rx scores, and lower scores were associated with non-adherence.

CONCLUSIONS—Negative beliefs about PD treatments are associated with lower quality of life and may be related to medication non-adherence. Further study of any causal relationship between beliefs and medication non-adherence in PD will inform the design of future patient-centered interventions to improve adherence.

Keywords

patient beliefs; psychometric; adherence; health belief model; Parkinson's disease

Introduction

Despite the efficacy of pharmacotherapy in Parkinson's disease (PD), adherence to antiparkinsonian drugs is as low as 33% by electronic medication monitoring technology, which is much lower than self-report.[1, 2] Suboptimal adherence with PD medications is associated with worsening disability, higher hospitalization rates, and greater healthcare expenditures.[2, 3]

The health belief model (HBM) provides a framework for exploring characteristics influencing health behaviors such as adherence. The HBM proposes that health behavior results from the interaction of three factors: 1) the existence of a salient health concern; 2) the perceived threat of that concern to one's wellbeing; and 3) the belief that a particular behavior would reduce the threat at an acceptable cost. Here, cost encompasses both financial burden and the effort required to overcome perceived barriers.[4]

Critical to an individual's perceived cost-benefit analysis of treatment are the beliefs one holds about the therapy itself. Medication beliefs may be grouped into two categories: 1) benefits of a treatment versus 2) the risks of said treatment or concerns held by the individual.[5] Instruments evaluating medication beliefs have been validated in multiple conditions, however, prior studies of patient-held beliefs in PD have described unique medication and symptom-specific phobias that are absent from such instruments. For example, patients often endorse fears surrounding the use of levodopa and the risk of developing dyskinesias.[6-9] Such fears may significantly influence adherence [7,9,13] .[6, 9, 10]

Adherence is also associated with demographic and clinical characteristics such as age, education, low health literacy, neuropsychiatric symptoms, disease severity, quality of life, polypharmacy, and medication cost in non-PD cohorts.[11-20] Emerging evidence suggests that these characteristics shape patients' beliefs about their health and treatments, and such beliefs form a potentially actionable obstacle to adherence.[5, 21-25] **Figure 1** illustrates our conceptual model to explain the characteristics shaping adherence in PD, with beliefs as an intermediary. Our objectives were to develop an instrument and conduct an initial pilot study to capture patient beliefs about PD medications, explore the associations of demographic and clinical characteristics with these beliefs, and define the relationship between beliefs and adherence. We hypothesized that older age, low health literacy, depression, apathy, and poor quality of life would be associated with negative medication beliefs in PD. We further postulated that positive beliefs would predict higher adherence.

Materials and Methods

Item generation, scale development, revision, and psychometric testing were accomplished in the following phases: initial focus groups for item generation and scale development, expert review of items, a second round of focus groups for content validity, and psychometric testing in a separate validation cohort. The study was approved by the University of Pennsylvania Institutional Review Board.

Subjects

Focus groups—We conducted 6 focus groups that consisted of a purposive sample of patients with PD or caregivers of patients drawn from existing local PD support groups

Validation cohort—Subjects in the validation cohort were drawn from an existing longitudinal cohort study, the University of Pennsylvania Udall Center for Parkinson's Research. These subjects had a diagnosis of PD based on established criteria, were 50 years of age or older, and had a score of ≥ 20 on the Montreal Cognitive Assessment (MoCA) at the time of the validation study visit. [26, 27] Subjects in the validation cohort did not participate in the focus groups.

Item generation and scale development

We employed the nominal group technique (NGT) for item generation.[28] After a warm-up exercise, participants went through cycles of NGT for 3 separate stimulus questions. The questions were: how PD had affected participants' lives, the key benefits of the dopaminergic medications taken for PD—either perceived or experienced; and the key risks of dopaminergic medications. Three initial focus groups were held, after which individual responses to the benefit and risk prompts were categorized into thematic groupings. The most common themes were converted to 24 items and scored on a 5-point Likert scale, ranging from “strongly disagree” (1 point) to “strongly agree” (5 points).

Item revision

The draft instrument and a standardized review tool were sent to 19 movement disorders experts across different institutions. Experts commented on readability, comprehensiveness,

applicability, and missing themes. The modified draft was then presented to a second round of focus groups for revision based on similar criteria. Based on these responses, the instrument wording was revised to include lay explanations of symptoms, and named the PD Medication Beliefs (PD-Rx) instrument.

Psychometric testing

The PD-Rx was administered to a cross-sectional sample of non-demented subjects with PD drawn from the Udall Center. We enrolled subjects who presented for an initial enrollment or annual follow-up visit between May 2013 and May 2014.

Primary Variables of Interest—In addition to data collected as part of the Udall study (described in detail elsewhere [29, 30] and briefly below), the *PD-Rx* was administered along with the Brief Medication Questionnaire (BMQ). The BMQ is a validated instrument to measure *adherence*. [31] The BMQ asks for each medication taken in the past week, including the name, strength, frequency of daily doses, number of doses missed, and indication. Subsequent questions ask whether the subject experiences specific problems with his medications (side effects, trouble remembering all doses, trouble affording medications, etc.). To assess test-retest reliability of the PD-Rx, a second copy of the instrument was mailed to all subjects within two weeks of their study visit.

We assessed adherence in two ways. First, the BMQ Adherence Risk Score (ARS) as mentioned above. [31] The ARS is scored categorically 0-4, with points given for 1) non-adherence with current drug regimen, 2) negative beliefs or motivational barriers, 3) recall barriers, and 4) access barriers. Second, we reviewed the subject's electronic medical record to obtain the medication list documented by the subject's neurologist from the most recent clinical visit or telephone encounter immediately preceding the study visit. All dopaminergic medications were converted to levodopa-equivalent doses (LEDs). [32] Chart review was conducted while blinded to BMQ and PD-Rx responses. Each physician-listed medication was compared to the subject-listed medications in the BMQ. The difference between the subject and physician total LED yielded a percentage LED adherence, with <80% or >120% defined as non-adherent.

Covariates of Interest—Demographic and clinical characteristics included *age at PD diagnosis* and *duration of symptoms*. The Unified Parkinson's Disease Rating Scale (UPDRS) was used to capture *disease severity*. [33, 34] The Hoehn and Yahr scale was used to classify the *stage of PD*. [35] *Apathy* was scored from 0-4 based on one UPDRS item, where 4 indicates complete loss of initiative. [34] The 15-item Geriatric Depression Scale was used to measure *depressive symptoms*, with scores ≥ 6 indicating depressed mood. [36] *Quality of life* was assessed using the Parkinson's Disease Questionnaire (PDQ-39) scored from 0-100 where higher scores denote poorer quality of life. [37] *Health literacy* was assessed with the Newest Vital Sign (NVS), a brief screening instrument that requires no handwriting and is untimed. [38]

Statistical analysis

Item response frequencies were reviewed for non-response, “not applicable” answers, and floor and ceiling effects for item reduction.[39] Cronbach's alpha was calculated to estimate internal consistency of the scale. Exploratory factor analysis was used to examine construct validity and identify unique domains.[40] Test-retest reliability was assessed using an intra-class correlation coefficient. Univariate analyses were conducted between the PD-Rx total score and individual covariates, using chi-square, t-tests, or ANOVA, as appropriate. Multivariable linear regression analyses were conducted using backwards stepwise elimination with PD-Rx total score as the dependent variable, and any covariates with p-value <0.2 in univariate analyses. Model fit was assessed by likelihood ratio testing.

The association between PD-Rx and ARS was modeled using ordered logistic regression. The proportional odds assumption was tested via likelihood ratio testing. The association between PD-Rx score and binary LED adherence was examined using logistic regression. All statistical analyses were two-sided with significance set at <0.05 level. Data analysis was performed using STATA 12.1 (StataCorp, College Station, TX).

Results

Sample Characteristics

Six focus groups ranged in size from 7 to 16 members for a total of 38 participants; 71% were patients and 29% caregivers. A total of 75 subjects participated in the validation cohort; their characteristics are displayed in Table 1. Significant apathy or depressed mood at the time of the study visit was uncommon, however 28% of the sample endorsed antidepressant use. By ARS criteria, 81.3% of subjects had at least two out of four barriers to adherence.

Item Generation and Scale Development

Initial items fell into several themes: 1) positive themes, including improvements in motor and non-motor symptoms, and restoration of normalcy; 2) negative themes such as known adverse effects, disruption of daily activity due to regimen complexity, and financial burden; and 3) future concern themes of tachyphylaxis, “running out of options”, and neuroprotection.

Expert reviewers recommended the removal of 7 original items, yielding 17 items in the pilot PD-Rx, none of which had >5% missing data. Item-level distribution of scores ranged from 1-5 for all except for one item. After factor analysis 3 items not specific to PD were deleted, as were 3 items with 20% “not applicable” responses. Table 2 shows the final 11-item PD-Rx scale and the percent choosing each option. The total possible score ranges from 11-55, with higher scores indicating benefits outweighing risks, or more positive medication beliefs.

Reliability and Validity

PD-Rx scores were normally distributed, with a mean of 38.9 (SD 4.9) and range of 29-51. Cronbach's alpha was 0.67. The final 11 items loaded onto 3 factors—motor improvement/

self-efficacy, current adverse effects, and future concerns. As the 3 factors explained only 58.3% of score variance, factor-based scoring was rejected in favor of an overall score. Test-retest reliability based on a subset of 56 subjects was 0.47 for the total score, and ranged from 0.00 to 0.60 for the individual items, as shown in Table 3.

Associations of PD-Rx Scores with Covariates of Interest

Table 4 shows unadjusted associations of medication beliefs with the covariates of interest. Depressed mood and poorer quality of life were inversely correlated with PD-Rx scores ($p = 0.02$ and $p < 0.01$, respectively). There was no association between PD-Rx score and the number of PD medications or total number of medications taken ($p = 0.76$, and 0.85 , respectively).

Table 5 displays the associations of individual covariates after adjusting for demographics and disease stage. Depressed mood was not independently associated with medication beliefs ($p = 0.56$), however the relationship between poor quality of life and negative beliefs remained significant (-0.13 points on PD-Rx for every point on PDQ-39, $p = 0.04$).

Associations of PD-Rx Scores with Adherence Measures

Using the ARS, with higher scores indicative of non-adherence, every point on the PD-Rx was associated with a 0.87-fold lower odds of non-adherence (95% CI 0.79-0.95, $p < 0.01$). This indicates that benefit-predominant beliefs are associated with fewer barriers to adherence. The association between PD-Rx and binary adherence, defined as 80-120% LED concordance, trended to significance, with an odds ratio of 1.11 for every point on the PD-Rx (95% CI 0.99-1.25, $p = 0.07$).

Discussion

We identified medication beliefs held by diverse populations of patients with PD and their caregivers and coalesced 11 common beliefs about dopaminergic medications covering both necessities and concerns into a patient-centered instrument with reasonably good psychometric characteristics. Poorer quality of life was associated with a lower total score on the PD-Rx (more negative beliefs), and lower scores were also related to at least one measure of adherence.

Two surprising findings in our study were the low overall test-retest reliability of the PD-Rx total score (0.47) and the highly variable reliability of individual items. Certain items were particularly susceptible to change; in particular, prompts such as “Taking my PD medications improves how fast or easily I move” or “Taking my PD medications makes walking easier”—had very low intra-class correlation coefficients. We hypothesize that subjects responded based on their functional status at the moment of instrument completion. As bradykinesia, rigidity, and certain components of gait are sensitive to on- and off-medication states that may fluctuate throughout the course of a day, responses to such questions may indicate a direct medication effect. Other items appear to probe more stable, non-state-dependent beliefs, such as offering some control over PD or slowing its progression. Therefore, an individual's subjective weighting of necessities versus concerns may vary over the course of a single day in parallel with PD motor fluctuations. The

alternative explanation is that the items are not adequately capturing the domains we believe them to be. Further revisions of the PD-Rx will include an item indicating “on” or “off” medication state, and we will examine the test-retest reliability between fluctuators and non-fluctuators to determine whether medication states affect the reporting of beliefs.

Both depressed mood and poorer quality of life were associated with lower PD-Rx scores, and poorer quality of life remained independently associated with negative beliefs after adjusting for confounders. This supports the hypothesis that medication beliefs may be a mediator between clinical characteristics and adherence. By identifying a patient with depressed mood or poor quality of life as potentially non-adherent, the clinician takes the first step towards intervening on behavior. However, without understanding the specific beliefs motivating that individual's behavior, one-size-fits-all interventions will remain the suboptimal standard.

Other covariates associated with non-adherence in prior work—such as education, racial minority, age, and low health literacy—were not significantly correlated with beliefs in the current study. For the former three, we may have failed to detect an association due to having a highly educated, nearly entirely white sample without much variability in age. Health literacy was also not related to beliefs. Prior studies finding that successful adherence required adequate health literacy relied upon pharmacy refill records as their measure of adherence, and our choice of adherence measures may have biased our results towards the null.[17]

Although we hypothesized that apathy and depressed mood might bias the estimation of risk in PD treatment, neither characteristic was independently associated with beliefs. This may be due to the lower than expected prevalence of both apathy and depressed mood in our sample.[41] However, 28% of our sample was treated with an antidepressant, suggesting that pharmacologic treatment blunted our ability to detect a signal.[42]

Because of the exploratory nature of this study, we relied on self-report and physician-documented medication lists to calculate PD medication adherence. Similar to prior PD studies relying on self-report, we found 25% of our sample was non-adherent by LED criteria.[2, 43] This is likely an underestimate. Studies using pharmacy refill data and pill counts have detected non-adherence approaching 67% and higher.[43] Therefore our results are likely biased towards the null.

This exploratory study has several limitations. First, there are potential sampling and healthy volunteer biases. One attempt to overcome this limitation was to implement in-home study visits for subjects with limited mobility. However, this initial pilot was conducted with a small and demographically homogeneous sample and may be underpowered despite recruiting at least five subjects per item. Second, focus groups bear the risk of social desirability bias. We addressed this by drawing our focus group participants from pre-existing support groups.[44] As mentioned above, patient-reported medication lists may significantly underestimate the prevalence of non-adherence, and provider-reported medication lists drawn from the electronic medical record are prone to errors.[45, 46] Future studies employing gold-standard adherence measures, such as electronic medication

monitoring devices, will be critical for validation of the PD-Rx. Finally, whether further validation proves an association between beliefs and adherence, the possibility that such beliefs may be refractory to intervention must be considered.

In summary, we present the initial pilot of an instrument to assess the medication beliefs held by patients with PD. With the PD-Rx, we sought to identify the beliefs that underlie medication phobia and non-adherence. Similar to providers directly asking patients about adherence, we felt that directly asking patients about fear of medication would lead to biased responses.[47] Further research is indicated to determine the effect of on- and off-medication states on beliefs, to test the PD-Rx in different samples, to confirm the association between beliefs and adherence using more robust measures, and to develop targeted interventions. Non-adherent PD patients face significantly higher rates of acute care visits and annual medical costs, even after adjusting for comorbidities.[43] Understanding the patient and disease-specific factors influencing adherence could guide clinicians to individualize counseling and patient education, though this remains to be tested in PD.[48]

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements including sources of support

Data contributed to this project by the Morris K. Udall Center at the Perelman School of Medicine at the University of Pennsylvania (P50 NS053488, Trojanowski JQ-PI; Weintraub D-Core B Leader; Chen-Plotkin A-Investigator and Project 1 PI, Chahine L-Investigator; Duda JE-Investigator; Dahodwala, N-Investigator; Rick J-Project-Project Manager). The authors thank Bonnie Svarstad, PhD for permission to use the Brief Medication Questionnaire in this study, and the patients and caregivers for their participation. Dr. Fleisher received support from NIH T32-NS-061779. Dr. Dahodwala is supported by NIA K23 AG034236. The Udall Center of Excellence is funded by a grant from NINDS (NS-053488).

References

1. Grosset KA, Bone I, Reid JL, Grosset D. Measuring therapy adherence in Parkinson's disease: a comparison of methods. *Journal of neurology, neurosurgery, and psychiatry*. 2006; 77:249–251.
2. Kulkarni AS, Balkrishnan R, Anderson RT, Edin HM, Kirsch J, Stacy MA. Medication adherence and associated outcomes in medicare health maintenance organization-enrolled older adults with Parkinson's disease. *Movement disorders : official journal of the Movement Disorder Society*. 2008; 23:359–365. [PubMed: 18074366]
3. Grosset D, Antonini A, Canesi M, Pezzoli G, Lees A, Shaw K, Cubo E, Martinez-Martin P, Rascol O, Negre-Pages L, Senard A, Schwarz J, Strecker K, Reichmann H, Storch A, Lohle M, Stocchi F, Grosset K. Adherence to antiparkinson medication in a multicenter European study. *Movement disorders : official journal of the Movement Disorder Society*. 2009; 24:826–832. [PubMed: 19191340]
4. Rosenstock IM, Strecher VJ, Becker MH. Social learning theory and the Health Belief Model. *Health Educ Q*. 1988; 15:175–183. [PubMed: 3378902]
5. Horne R, Weinman J. Patients' beliefs about prescribed medicines and their role in adherence to treatment in chronic physical illness. *Journal of psychosomatic research*. 1999; 47:555–567. [PubMed: 10661603]
6. Schlesinger I, Rabinowitz D. Medication phobia: a new cause of drug noncompliance in Parkinson disease. *Clinical neuropharmacology*. 2011; 34:220–223. [PubMed: 22027928]
7. Vlaar A, Hovestadt A, van Laar T, Bloem BR. The treatment of early Parkinson's disease: levodopa rehabilitated. *Pract Neurol*. 2011; 11:145–152. [PubMed: 21551108]

8. Fujimoto K, Murata M, Hattori N, Kondo T. [Patients' perspective on Parkinson disease therapies: results of a large-scale survey in Japan]. *Brain Nerve*. 2011; 63:255–265. [PubMed: 21386127]
9. Hung SW, Adeli GM, Arenovich T, Fox SH, Lang AE. Patient perception of dyskinesia in Parkinson's disease. *J Neurol Neurosurg Psychiatry*. 2010; 81:1112–1115. [PubMed: 20667858]
10. Horne R, Chapman SC, Parham R, Freemantle N, Forbes A, Cooper V. Understanding patients' adherence-related beliefs about medicines prescribed for long-term conditions: a meta-analytic review of the Necessity-Concerns Framework. *PLoS One*. 2013; 8:e80633. [PubMed: 24312488]
11. Daley DJ, Myint PK, Gray RJ, Deane KH. Systematic review on factors associated with medication non-adherence in Parkinson's disease. *Parkinsonism & related disorders*. 2012; 18:1053–1061. [PubMed: 23022461]
12. Bainbridge JL, Ruscin JM. Challenges of treatment adherence in older patients with Parkinson's disease. *Drugs & aging*. 2009; 26:145–155. [PubMed: 19220071]
13. DiMatteo MR, Lepper HS, Croghan TW. Depression is a risk factor for noncompliance with medical treatment: meta-analysis of the effects of anxiety and depression on patient adherence. *Archives of Internal Medicine*. 2000; 160:2101–2107. [PubMed: 10904452]
14. Insel K, Morrow D, Brewer B, Figueredo A. Executive function, working memory, and medication adherence among older adults. *The journals of gerontology. Series B, Psychological sciences and social sciences*. 2006; 61:P102–107.
15. Maguire LK, Hughes CM, McElnay JC. Exploring the impact of depressive symptoms and medication beliefs on medication adherence in hypertension—a primary care study. *Patient education and counseling*. 2008; 73:371–376. [PubMed: 18692978]
16. Gellad WF, Grenard JL, Marcum ZA. A systematic review of barriers to medication adherence in the elderly: looking beyond cost and regimen complexity. *Am J Geriatr Pharmacother*. 2011; 9:11–23. [PubMed: 21459305]
17. Gazmararian JA, Kripalani S, Miller MJ, Echt KV, Ren J, Rask K. Factors associated with medication refill adherence in cardiovascular-related diseases: a focus on health literacy. *J Gen Intern Med*. 2006; 21:1215–1221. [PubMed: 17105519]
18. Vermeire E, Hearnshaw H, Van Royen P, Denekens J. Patient adherence to treatment: three decades of research. A comprehensive review. *J Clin Pharm Ther*. 2001; 26:331–342. [PubMed: 11679023]
19. Panos SE, Del Re AC, Thames AD, Arentsen TJ, Patel SM, Castellon SA, Singer EJ, Hinkin CH. The impact of neurobehavioral features on medication adherence in HIV: evidence from longitudinal models. *AIDS Care*. 2014; 26:79–86. [PubMed: 23756102]
20. Kale MS, Federman AD, Krauskopf K, Wolf M, O'Connor R, Martynenko M, Leventhal H, Wisnivesky JP. The Association of Health Literacy with Illness and Medication Beliefs among Patients with Chronic Obstructive Pulmonary Disease. *PLoS One*. 2015; 10:e0123937. [PubMed: 25915420]
21. Graham J, Bennett IM, Holmes WC, Gross R. Medication beliefs as mediators of the health literacy-antiretroviral adherence relationship in HIV-infected individuals. *AIDS Behav*. 2007; 11:385–392. [PubMed: 17053858]
22. Figueiras MJ, Alves NC, Marcelino D, Cortes MA, Weinman J, Horne R. Assessing lay beliefs about generic medicines: Development of the generic medicines scale. *Psychology, Health & Medicine*. 2009; 14:311–321.
23. French DP, James D, Horne R, Weinman J. Causal beliefs and behaviour change post- myocardial infarction: how are they related? *British journal of health psychology*. 2005; 10:167–182. [PubMed: 15969848]
24. Horne R, Buick D, Fisher M, Leake H, Cooper V, Weinman J. Doubts about necessity and concerns about adverse effects: identifying the types of beliefs that are associated with non- adherence to HAART. *International Journal of STD & AIDS*. 2004; 15:38–44. [PubMed: 14769170]
25. Horne R, Graupner L, Frost S, Weinman J, Wright SM, Hankins M. Medicine in a multi- cultural society: the effect of cultural background on beliefs about medications. *Social science & medicine (1982)*. 2004; 59:1307–1313. [PubMed: 15210101]
26. Hughes AJ, Daniel SE, Kilford L, Lees AJ. Accuracy of clinical diagnosis of idiopathic Parkinson's disease: a clinico-pathological study of 100 cases. *Journal of neurology, neurosurgery, and psychiatry*. 1992; 55:181–184.

27. Chou KL, Amick MM, Brandt J, Camicioli R, Frei K, Gitelman D, Goldman J, Growdon J, Hurtig HI, Levin B, Litvan I, Marsh L, Simuni T, Troster AI, Uc EY, Parkinson Study Group Cognitive/Psychiatric Working G. A recommended scale for cognitive screening in clinical trials of Parkinson's disease. *Movement disorders : official journal of the Movement Disorder Society*. 2010; 25:2501–2507. [PubMed: 20878991]
28. Gallagher M, Hares T, Spencer J, Bradshaw C, Webb I. The nominal group technique: a research tool for general practice? *Fam Pract*. 1993; 10:76–81. [PubMed: 8477899]
29. Morley JF, Xie SX, Hurtig HI, Stern MB, Colcher A, Horn S, Dahodwala N, Duda JE, Weintraub D, Chen-Plotkin AS, Van Deerlin V, Falcone D, Siderowf A. Genetic influences on cognitive decline in Parkinson's disease. *Mov Disord*. 2012; 27:512–518. [PubMed: 22344634]
30. Watson GS, Cholerton BA, Gross RG, Weintraub D, Zabetian CP, Trojanowski JQ, Montine TJ, Siderowf A, Leverenz JB. Neuropsychologic assessment in collaborative Parkinson's disease research: a proposal from the National Institute of Neurological Disorders and Stroke Morris K. Udall Centers of Excellence for Parkinson's Disease Research at the University of Pennsylvania and the University of Washington. *Alzheimers Dement*. 2013; 9:609–614. [PubMed: 23164549]
31. Svarstad BL, Chewning BA, Sleath BL, Claesson C. The Brief Medication Questionnaire: a tool for screening patient adherence and barriers to adherence. *Patient education and counseling*. 1999; 37:113–124. [PubMed: 14528539]
32. Tomlinson CL, Stowe R, Patel S, Rick C, Gray R, Clarke CE. Systematic review of levodopa dose equivalency reporting in Parkinson's disease. *Movement disorders : official journal of the Movement Disorder Society*. 2010; 25:2649–2653. [PubMed: 21069833]
33. Goetz CG, Fahn S, Martinez-Martin P, Poewe W, Sampaio C, Stebbins GT, Stern MB, Tilley BC, Dodel R, Dubois B, Holloway R, Jankovic J, Kulisevsky J, Lang AE, Lees A, Leurgans S, LeWitt PA, Nyenhuis D, Olanow CW, Rascol O, Schrag A, Teresi JA, Van Hilten JJ, LaPelle N. Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale (MDS UPDRS): Process, format, and clinimetric testing plan. *Mov Disord*. 2007; 22:41–47. [PubMed: 17115387]
34. Goetz CG, Tilley BC, Shaftman SR, Stebbins GT, Fahn S, Martinez-Martin P, Poewe W, Sampaio C, Stern MB, Dodel R, Dubois B, Holloway R, Jankovic J, Kulisevsky J, Lang AE, Lees A, Leurgans S, LeWitt PA, Nyenhuis D, Olanow CW, Rascol O, Schrag A, Teresi JA, van Hilten JJ, LaPelle N, Movement Disorder Society URTF. Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS): scale presentation and clinimetric testing results. *Movement disorders : official journal of the Movement Disorder Society*. 2008; 23:2129–2170. [PubMed: 19025984]
35. Goetz CG, Poewe W, Rascol O, Sampaio C, Stebbins GT, Counsell C, Giladi N, Holloway RG, Moore CG, Wenning GK, Yahr MD, Seidl L, Movement Disorder Society Task Force on Rating Scales for Parkinson's D. Movement Disorder Society Task Force report on the Hoehn and Yahr staging scale: status and recommendations. *Movement disorders : official journal of the Movement Disorder Society*. 2004; 19:1020–1028. [PubMed: 15372591]
36. Sheikh JI, Yesavage JA. Geriatric Depression Scale (GDS): Recent evidence and development of a shorter version. *Clinical Gerontologist*. 1986; 5:165–172.
37. Jenkinson C, Fitzpatrick R, Peto V, Greenhall R, Hyman N. The Parkinson's Disease Questionnaire (PDQ-39): development and validation of a Parkinson's disease summary index score. *Age and Ageing*. 1997; 26:353–357. [PubMed: 9351479]
38. Osborn CY, Weiss BD, Davis TC, Skripkauskas S, Rodrigue C, Bass PF, Wolf MS. Measuring adult literacy in health care: performance of the newest vital sign. *American Journal of Health Behavior* 31 Suppl. 2007; 1:S36–46.
39. Streiner, DL.; Norman, GR. *Health Measurement Scales: a Practical Guide to Their Development and Use*. Oxford University Press; Oxford: 2008.
40. Streiner DL. Figuring out factors: the use and misuse of factor analysis. *Canadian journal of psychiatry.Revue canadienne de psychiatrie*. 1994; 39:135–140. [PubMed: 8033017]
41. Pedersen KF, Larsen JP, Alves G, Aarsland D. Prevalence and clinical correlates of apathy in Parkinson's disease: a community-based study. *Parkinsonism Relat Disord*. 2009; 15:295–299. [PubMed: 18801696]

42. Aarsland D, Marsh L, Schrag A. Neuropsychiatric symptoms in Parkinson's disease. *Mov Disord.* 2009; 24:2175–2186. [PubMed: 19768724]
43. Davis KL, Edin HM, Allen JK. Prevalence and cost of medication nonadherence in Parkinson's disease: evidence from administrative claims data. *Movement disorders : official journal of the Movement Disorder Society.* 2010; 25:474–480. [PubMed: 20131374]
44. Dahodwala N, Siderowf A, Xie M, Noll E, Stern M, Mandell DS. Racial differences in the diagnosis of Parkinson's disease. *Movement disorders : official journal of the Movement Disorder Society.* 2009; 24:1200–1205. [PubMed: 19412929]
45. Manley HJ, Drayer DK, McClaran M, Bender W, Muther RS. Drug record discrepancies in an outpatient electronic medical record: frequency, type, and potential impact on patient care at a hemodialysis center. *Pharmacotherapy.* 2003; 23:231–239. [PubMed: 12596688]
46. Wagner MM, Hogan WR. The accuracy of medication data in an outpatient electronic medical record. *J Am Med Inform Assoc.* 1996; 3:234–244. [PubMed: 8723614]
47. Valdeoriola F, Coronell C, Pont C, Buongiorno MT, Camara A, Gaig C, Compta Y, Group AS. Socio-demographic and clinical factors influencing the adherence to treatment in Parkinson's disease: the ADHESON study. *European journal of neurology : the official journal of the European Federation of Neurological Societies.* 2011; 18:980–987.
48. Clifford S, Barber N, Horne R. Understanding different beliefs held by adherers, unintentional nonadherers, and intentional nonadherers: application of the Necessity-Concerns Framework. *J Psychosom Res.* 2008; 64:41–46. [PubMed: 18157998]

Figure 1.
Conceptual Model of Factors Influencing Medication Adherence in Parkinson's Disease
Parkinson's Disease

Table 1

Characteristics of validation study participants

Variable	% (n = 75)
Male, %	69.3
Mean age, years (SD)	68.2 (7.1)
Race, %	
White	96.0
Ethnicity, %	
Non-Hispanic	100.0
Mean education, years (SD)	16.4 (2.2)
16 years education, %	73.3
Low health literacy by NVS criteria, %	30.7
Presence of care partner in home, %	90.7
Median PD duration, years (IQR)	10.1 (5-14)
Hoehn & Yahr PD stage, %	
1	8.0
2	61.3
3	29.3
5	1.3
Median UPDRS Part III (Motor) subtotal, (IQR)	20 (15-30)
Mean cognitive performance on MoCA (SD)	26.6 (2.4)
Apathy (UPDRS 1), %	
0-1	86.7
2-3	13.3
Depression by GDS criteria, %	5.3
Median GDS score (IQR)	2 (1-4)
Median quality of life, PDQ39 (IQR)	15.5 (7.1-24.6)
Medication regimen	
Median levodopa dose equivalents prescribed (IQR)	660 (420-950)
Mean number of PD-related medications prescribed (SD)	3.4 (1.6)
Motor symptom-related medications, median (IQR)	2 (1-3)
Non-motor symptom-related medications, median (IQR)	1 (0-2)
Median number of non-PD medications prescribed (IQR)	5 (2-7)
Non-adherence by LED criteria	25.3

Variable	% (n = 75)
Adherence barriers by ARS criteria	
1	18.7
2	44.0
3	29.3
4	8.0

Footnotes: SD= Standard deviation. NVS= Newest Vital Sign. PD= Parkinson's Disease. UPDRS= Unified Parkinson's Disease Rating Scale, Part III range 0-108, higher scores indicate more severe motor impairment. IQR = Interquartile range. MoCA= Montreal Cognitive Assessment, range 0-30, lower scores indicate cognitive impairment. PDQ39= Parkinson's Disease Questionnaire-39, range 0-100, higher scores indicate poorer quality of life. GDS= Geriatric Depression Scale, range 0-15, >6 indicates depressive symptoms. LED= Levodopa equivalent dose. ARS = Adherence Risk Score.

Table 2

Parkinson's Disease Medication Beliefs Scale – PD-Rx

Your Experience with Medications for Parkinson's Disease Taking medications for Parkinson's Disease, or PD, can be complicated. All medications can have benefits (good effects) and risks (bad effects), and these effects may happen right after taking the medicine, or sometime in the future. We are interested in learning about your experience with these medications, your beliefs about them, and how important some of these effects are to you. Please mark how strongly you agree with each statement below by placing an "X" in the appropriate box. Each statement may or may not apply to you; if it does not apply, mark "Neutral." <i>There are no wrong answers.</i> "Taking my PD medications..."					
	[1] Strongly disagree, %	[2] Disagree, %	[3] Neutral, %	[4] Agree, %	[5] Strongly agree, %
1. ...improves how fast or easily I move	1.3	1.3	25.3	36.0	28.0
2. ...causes extra unwanted movements* (such as dyskinesias or "the wiggles")	30.7	26.7	14.7	20.0	2.7
3. ...makes walking easier (including arm swing, shuffling, or freezing)	2.7	6.7	21.3	32.0	26.7
4. ...gives me bad side effects now* (like nausea, lightheadedness, or drowsiness)	29.3	16.0	24.0	20.0	5.3
5. ...improves my mood	5.3	4.0	53.3	32.0	0
6. ...is a burden that disrupts my daily routine*	48.0	25.3	13.3	8.0	2.7
7. ...helps me live a more normal life	4.0	5.3	17.3	48.0	25.3
8. ...will lead to higher and higher doses in the future*	2.7	18.7	38.7	26.7	8.0
9. ...gives me some control over my PD	34.7	28.0	14.7	8.0	8.0
10. ...slows the progression of my PD	6.7	12.0	37.3	33.3	8.0
11. ...will cause serious side effects in the future*	2.7	28.0	44.0	16.0	2.7

* Items 2, 4, 8, and 11 are reverse scored

Table 3

Test-Retest Reliability of PD-Rx Items and Total Score

	Intra-class correlation coefficient (n = 56)
...improves how fast or easily I move	0.06
...causes extra unwanted movements*	0.41
...makes walking easier	0.00
...gives me bad side effects now*	0.42
...improves my mood	0.60
...is a burden that disrupts my daily routine*	0.41
...helps me live a more normal life	0.47
...will lead to higher and higher doses in the future*	0.16
...gives me some control over my PD	0.57
...slows the progression of my PD	0.47
...will cause serious side effects in the future*	0.52
Total Score Intra-class correlation coefficient	0.47

Table 4

Associations of PD-Rx with Covariates of Interest

Characteristic	Mean PD-Rx Score (possible range 11-55)	P value
Sex		0.94
Men	38.90	
Women	39	
Age	33.11+ 0.85 for every 10 years of age	0.29
Race		0.12
African-American	34.67	
White	39.11	
Education		0.57
<16 years	38.40	
16 years	39.13	
Health literacy		0.63
Low	39.35	
Adequate	38.75	
Caregiver presence		0.68
Yes	39.12	
No	37.14	
Number of medications		
For PD motor symptoms only	38.67+ 0.11 for every medication	0.84
For PD motor + non-motor symptoms	39.31- 0.11 for every medication	0.76
For all conditions	39.15- 0.03 for every medication	0.85
PD Duration	38.54 + 0.39 for every 10 yrs of disease	0.64
PD Stage		
H&Y 1 or 2	39.08	0.71
H&Y 3 or higher	38.61	
PD Motor Severity	38.83 + 0.04 for every 10 pts on UPDRS III	0.93
Cognition	39.76 – 0.03 for every 1 pt on MoCA	0.90
Apathy		0.44
0 or 1	39.11	
2 or 3	37.80	
Depression	40.35 – 0.58 for every 1 pt on GDS	0.02
Quality of life	41.32 – 0.14 for every 1 pt on PDQ39	<0.01

Footnotes: Gender, race, education, health literacy, caregiver presence, caregiver health literacy, PD stage, and apathy: t-test. Age, PD duration, PD motor severity, cognition, depression, quality of life: linear regression. PD= Parkinson's Disease. H&Y= Hoehn & Yahr Stage. UPDRS= Unified

Parkinson's Disease Rating Scale. MoCA= Montreal Cognitive Assessment. GDS= Geriatric Depression Scale. QoL= Quality of Life. PDQ39= Parkinson's Disease Questionnaire-39.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 5

Multivariable model for PD-Rx Score

Characteristic	Regression coefficient	Standard Error of Regression Coefficient	95% Confidence Interval	P value
Age, years *	<0.01	0.90	−0.17, 0.17	0.98
Female	0.80	1.26	−1.71, 3.30	0.53
African-American race	−1.62	3.10	−7.81, 4.58	0.60
College degree or higher	−0.68	1.16	−2.99, 1.63	0.56
H&Y Stage 3 or higher (vs. Stage 1 or 2)	0.55	1.34	−2.14, 3.23	0.69
Depression, for every 1 pt on GDS	−0.18	0.31	−0.79, 0.43	0.56
Low QoL, for every 1 pt on PDQ-39	−0.13	0.06	−0.26, −0.00	0.04

Footnotes: R-squared: 0.14, constant 41.41; **bold** font denotes statistical significance.

* Age is not statistically significant, coefficient of 0.002, however it is retained due to significant confounding of other covariates. H&Y= Hoehn & Yahr Stage. GDS= Geriatric Depression Scale. PDQ39= Parkinson's Disease Questionnaire-39.