Supplementary Table S1. General characteristics of patients included in the validation cohort.

|                         | Protocol A      | Protocol B      | Protocol C      | Total       |
|-------------------------|-----------------|-----------------|-----------------|-------------|
| TE / TR (ms)            | 83 / 7800       | 96 / 8200       | 108 / 5700      |             |
| Voxel size              | 2 × 2 × 2       | 2 × 2 × 2       | 2 × 2 × 3       |             |
| Directions              | 64              | 64              | 30              |             |
| Number of patients      | 8               | 4               | 3               | 8 / 7       |
| Sex (men/women)         | 4 / 4           | 2 / 2           | 2 / 1           | 8 / 7       |
| Age (years)             | 65.1 ± 4.1      | 62.5 ± 5.8      | 72.3 ± 5.5      | 65.9 ± 5.7  |
| Disease duration (years)| 8.0 ± 2.4       | 6.5 ± 3.5       | 7.7 ± 2.1       | 7.5 ± 2.6   |
| Subtype (PAGF/PD/RS/CBS)| 3 / 2 / 2 / 1   | 3 / 1 / 0 / 0   | 3 / 0 / 0 / 0   | 9 / 3 / 2 / 1 |
| UPDRS-III (motor)       | 45.5 ± 18.4     | 26.5 ± 11.3     | 32.0 ± 17.3     | 37.9 ± 18.1 |
| PIGD                    | 12.0 ± 4.7      | 7.3 ± 6.0       | 10.8 ± 3.3      | 11.2 ± 5.4  |
| MHY                     | 4.3 ± 1.0       | 3.8 ± 1.0       | 3.8 ± 0.9       | 4.1 ± 1.0   |
| <3                      | 0               | 0               | 0               | 0           |
| 3                       | 3               | 2               | 1               | 6           |
| 4                       | 0               | 1               | 0               | 1           |
| 5                       | 5               | 1               | 2               | 8           |
| LEDD (mg/day)           | 921.9 ± 318.3   | 917.5 ± 301.8   | 660.8 ± 302.2   | 868.5 ± 307.9 |

Data are presented as counts or means ± standard deviations, as appropriate. Protocol A was used from July 2008 to April 2010; protocol B from Jun 2011 to Nov 2011; protocol C from Sep 2013 to Nov 2017. Data on age and disease and the results of clinical assessments were collected at baseline. Abbreviations: TR, repetition time; TE, echo time; UPDRS-III, motor subscale of Unified Parkinson’s Disease Rating Scale; PIGD, postural instability and gait disorder staging; MHY, modified Hoehn and Yahr staging; LEDD, levodopa equivalent daily dose.
### Supplementary Table S2. Nomenclature of the features for each assessment in the predictive model.

| UPDRS-III: | Modified cytoarchitectonic | MNI (X, Y, Z) |
|------------|---------------------------|--------------|
| MD50_PhG_L_6_1: Para-hippocampal gyrus (Left side) | A35/36r, rostral area 35/36 | (−27, −7, −34) |
| MD10_PrG_L_6_2: Precentral gyrus (Left side) | Asecdl, caudal dorsolateral area 6 | (−32, −9, 58) |
| FA90_GP_L: globus pallidus (Left side) | GP, globus pallidus | (−22, −2, 4) |
| MD10_Tha_L_8_3: Thalamus (Left side) | Sth, sensory thalamus | (−18, −23, 4) |
| FA90_SCL_R_5_4: Superior parietal lobule (Right side) | A7pc, postcentral area 7 | (23, −43, 67) |
| FA90_STG_R_6_1: Superior temporal gyrus (Right side) | A38m, medial area 38 | (31, 15, −34) |
| MD10_Amyg_L_2_1: Amygdala (Left side) | mAmyg, medial amygdala | (−19, −2, −20) |
| MD10_Tha_L_8_8: Thalamus (Left side) | IPFtha, lateral pre-frontal thalamus | (−11, −14, 2) |
| MD90_IPk_L_6_2: Inferior parietal lobule (Left side) | A39rd, rostradorsal area 39 (Hip3) | (−38, −61, 46) |
| FA90_VM_Put_R: Ventromedial putamen (Right side) | vmPu, ventromedial putamen | (22, 8, −1) |
| FA90_MFG_L_7_6: Middle frontal gyrus (Left side) | A6vl, ventrolateral area 6 | (−32, 4, 35) |

| PIGD: | | |
| MD90_INS_R_6_5: Insular gyrus (Right side) | dlgl, dorsal granular insula | (39, −7, 8) |
| FA10_MTG_R_4_3: Middle temporal gyrus (Right side) | A37dl, dorsolateral area 37 | (60, −53, 3) |
| MD90_MFG_R_7_2: Middle frontal gyrus (Right side) | IntF, inferior frontal junction | (42, 11, 39) |
| MD90_PrG_R_6_2: Precentral gyrus (Right side) | Asecdl, caudal dorsolateral area 6 | (33, −7, 57) |
| FA90_IGT_R_7_2: Inferior temporal gyrus (Right side) | A37elv, extreme lateralventral area 37 | (48, 35, 13) |
| FA90_MGF_R_4_4: Middle frontal gyrus (Right side) | aSTS, anterior superior temporal sulcus | (58, −16, −10) |
| FA90_PoG_L_4_3: Postcentral gyrus (Left side) | A2, area 2 | (−46, −30, 50) |
| MD10_Amyg_R_2_1: Amygdala (Right side) | mAmyg, medial amygdala | (19, −2, −19) |
| MD90_MVOCC_L_5_3: Medioventral occipital cortex (Left side) | cCunc, caudal cuneus gyrus | (−6, −94, 1) |
| FA10_ITG_L_7_6: Inferior temporal gyrus (Left side) | A20cl, caudolateral of area 20 | (−59, −42, −16) |

| MHY: | | |
| MD50_MFG_L_7_5: Middle frontal gyrus (Left side) | A8vI, ventrolateral area 8 | (−33, 23, 45) |
| FA90_IPL_R_5_4: Inferior parietal lobule (Right side) | A40c, caudal area 40 (PFm) | (57, −44, 38) |
| FA50_NAC_L: Nucleus accumbens (Left side) | NAC, nucleus accumbens | (−17, 3, −9) |
| FA90_SCL_L_5_3: Superior parietal lobule (Left side) | A5I, lateral area 5 | (−33, −47, 50) |
| FA90_Tha_L_8_4: Thalamus (Left side) | rTha, rostral thalamic thalamus | (3, −13, 5) |
| MD10_IGF_R_6_4: Inferior frontal gyrus (Right side) | A45r, rostral area 45 | (51, 36, −1) |
| FA50_IGT_R_7_2: Inferior temporal gyrus (Right side) | A37elv, extreme lateralventral area 37 | (53, −52, −18) |
| FA10_ITG_L_7_6: Inferior temporal gyrus (Left side) | A20cl, caudolateral of area 20 | (−59, −42, −16) |
| MD10_PoG_R_6_4: Precentral gyrus (Left side) | A4t, area 4 (trunk region) | (−13, −20, 73) |
| MD50_Amyg_L_2_1: Amygdala (Left side) | mAmyg, medial amygdala | (−19, −2, −20) |
| FA90_MGF_L_7_6: Middle frontal gyrus (Left side) | A6vl, ventrolateral area 6 | (−32, 4, 55) |

| LEDD: | | |
| FA90_STG_R_6_1: Superior temporal gyrus (Right side) | A38m, medial area 38 | (31, 15, −34) |
| MD50_Amyg_R_2_2: Amygdala (Right side) | mAmyg, medial amygdala | (28, −3, −20) |
| MD50_CG_R_7_6: Cingulate gyrus (Right side) | A22c, caudal area 24 | (6, −20, 40) |
| MD90_PHF_L_6_3: Para-hippocampal gyrus (Left side) | lateral PPFC, posterior parahippocampal gyrus | (−28, −32, −18) |
| FA10_VM_Put_R: Ventromedial putamen (Right side) | vmPu, ventromedial putamen | (22, 8, −1) |
| FA90_ORT_R_6_2: Orbital gyrus (Right side) | A12/47o, orbital area 12/47 | (40, 39, −14) |
| MD10_PoG_L_6_4: Precentral gyrus (Left side) | A4t, area 4 (trunk region) | (−13, −20, 73) |
| MD10_PoG_L_4_3: Postcentral gyrus (Left side) | A2, area 2 | (−46, −30, 50) |
| FA90_PCL_R_2_1: Paracentral lobule (Right side) | A1/2/3ll, area 1/2/3 (low lateral PFHC, posterior parahippocampal gyrus) | (10, −34, 54) |
| MD50_PoG_L_4_3: Postcentral gyrus (Right side) | A2, area 2 | (48, −24, 48) |
| FA10_SCL_R_5_4: Superior parietal lobule (Right side) | A7pc, postcentral area 7 | (23, −43, 67) |

The nomenclature – including the diffusion index, the percentile values, as well as the modified cytoarchitectonic and Montreal Neurological Institute (MNI) coordinates – for each assessment in the predictive model was extracted from Fan Lingzhong et al. (2016). Abbreviations: MD, mean diffusivity; FA, fractional anisotropy; _90, 90th percentile of the maximum value in the VOI; _50, 50th percentile of the median value in the VOI; _10, 10th percentile of the minimum value in the VOI. UPDRS-III, motor subscale of Unified Parkinson’s Disease Rating Scale; PIGD, postural instability and gait disorder staging; MHY, modified Hoehn and Yahr staging; LEDD, levodopa equivalent daily dose.