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## Background

**Parkinson's Disease** is a neurodegenerative disease that results from a decrease in dopamine production. It affects cognitive and motor function.

**Patient Population:** Affects ~1 million people in the US [3] and the average age of diagnosis is 66 years [1]

**Problem:** PD often leads to instability in the posterior direction (retropulsion) leading to falls which can be a cause of extended hospitalizations and high costs

In a 6-month period, **25% of PD patients experience retropulsion** [2]

**Consequences:**

Physical - patient cannot maintain proper posture, gait disturbances are hard to recover from, difficulty performing everyday activities

Psychosocial - patients often struggle with not having a sense of independence, frequent falls can create a fear of walking

Financial - The cost of treatment after a fall is significant (the total cost of PD for individuals, families, and the U.S. government is \$51.9 Billion each year) [4,5]

## Device Specifications

**Solution: handlebar and wheel accessories that complement a standard walker to reduce the risk of retropulsion**

### Device Requirements

- Device maintains patient's normal posterior pelvic tilt (6-8°)
- Wheels maintain a speed of 0.70-1.30 m/s to promote smooth gait patterns

### User-Friendly Requirements

- Time to set up device is less than 5 minutes
- Device is stable and easy to use; it should not tip over with less than 150 lbs of force applied to forearm supports at 45-90°

## Market Validation

Average fall-related healthcare costs >\$15,000 per patient [7]

Increased healthcare resource allocation: more fall-related ED visits, hospitalizations, and outpatient services

PD patient falls:

- 25% (~250,000 patients) in a 6-month period [2]
- >50% (~500,000 patients) in a 12-month period [8-9]

Estimated \$3.75M-\$7.5M per year in fall-related healthcare costs for PD patients in US

## Verification Testing and Conclusions

Gait velocity and pelvic tilt tested - four trials with variable wheel and handlebar components  
Handlebar revision - acetal plastic changed to PVC pipe to increase strength; added PVC pipe reinforcement

Wheel revision - magnetic discs changed to pneumatic system - strength of magnetic field could have adverse effects (patients with pacemakers, implants, etc.)

Retropulsion poses a serious fall risk to PD patients [2]

These modifications limit gait disturbances and provide a smooth ride for PD patients, while also being cheaper and more accessible than other devices

This solution tackles retropulsion specifically while addressing specific concerns such as posture, smooth gate patterns, and stability

## Advantages Versus Existing Solutions

Device	Effectiveness	Ease of use
<b>Upright Rollator</b>	-Affordable -Provides a stabilizing effect to prevent retropulsion	-Not easily accessible -Not easily portable
<b>Weighted Vests</b>	-Portable -Provides a stabilizing effect to prevent retropulsion -Improves gait speed	-Not easily accessible or affordable -Requires patient to maintain consistent visits with physical therapists to adjust weights -Balance-Based-Torso-Weighting exam needed to determine the weight placement
<b>U-Shaped Wheeled Walkers</b>	-Provides a stabilizing effect to prevent side and forward falls, but does not prevent retropulsion -Helpful for Parkinson's patients with difficulty turning -Brakes in the hands can stop device when needed	-Not easily accessible -Not affordable -Not easily portable -Less effective on uneven surfaces
<b>Standard Walker</b>	-Accessible -Affordable -Portable	-Does not help prevent retropulsion
<b>Our Solution</b>	-Handlebar component maintains stability of system and maintains normal pelvic tilt -Lockable swivel; pneumatic wheels maintains safe gait speed and pacing -Thrust bearing promote smooth gait	-Easy to set up -Portable Easy to use

PVC/PLA

handlebar:  
maintains stability  
and normal pelvic  
tilt

Lockable swivel  
pneumatic wheels:  
provide rotational  
resistance to  
maintain optimal  
gait velocity



Thrust bearings:  
promote smooth  
gait and limit  
disturbances

## References

[1] S. L. Wong, H. Gilmour, and P. L. Ramage-Morin, "Parkinson's disease: Prevalence, diagnosis and impact," Research Gate, 19-Nov-2014. [Online]. Available: [https://www.researchgate.net/profile/Heather-Gilmour-2/publication/268512906\\_Parkinson%27s\\_Disease\\_Prevalence\\_diagnosis\\_and\\_impact](https://www.researchgate.net/profile/Heather-Gilmour-2/publication/268512906_Parkinson%27s_Disease_Prevalence_diagnosis_and_impact) [Accessed: 01-Oct-2021]. [2] B. Lindholm, P. Hagell, O. Hansson, and M. H. Nilsson, "Prediction of falls and/or near falls in people with mild Parkinson's disease," PLoS one, 30-Jan-2015. [Online]. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4311993/>. [Accessed: 01-Oct-2021]. [3] "Understanding Parkinson's - Statistics," Parkinson's Foundation. [Online]. Available: <https://www.parkinson.org/Understanding-Parkinsons/Statistics>. [Accessed: 08-Oct-2021]. [4] Parkinson's Disease Economic Burden on Patients, Families and the Federal Government Is \$52 Billion, Doubling Previous Estimates. (2019, June 13). The Michael J. Fox Foundation for Parkinson's Research | Parkinson's Disease. [5] Yang, W., Hamilton, J.L., Kopil, C. et al. Current and projected future economic burden of Parkinson's disease in the U.S.. npj Parkinson's Dis. 6, 15 (2020). <https://doi.org/10.1038/s41531-020-0117-1> [6] Verboket RD, Mühlenfeld N, Woschek M, et al. Stationäre Versorgungskosten, kostenverursachende Faktoren und potenzielle Vergütungen Probleme bei durch Morbus Parkinson bedingten Frakturen [Inpatient treatment costs, cost-driving factors and potential reimbursement problems due to fall-related fractures in patients with Parkinson's disease]. Chirurg. 2020;91(5):421-427. doi:10.1007/s00104-019-01074-w [7] François C, Biaggioni I, Shibao C, et al. Fall-related healthcare use and costs in neurogenic orthostatic hypotension with Parkinson's disease [published correction appears in J Med Econ. 2017 Nov;20(11):1216]. J Med Econ. 2017;20(5):525-532. doi:10.1080/13696998.2017.1284668 [8] Bloem BR, Grimbergen YA, Cramer M, Willemsen M, Zwiderman AH. Prospective assessment of falls in Parkinson's disease. J Neurol. 2001;248(11):950-958. doi:10.1007/s004150170047 [9] Rudzińska M, Bukowczan S, Stożek J, et al. The incidence and risk factors of falls in Parkinson disease: prospective study. Neurol Neurochir Pol. 2013;47(5):431-437. doi:10.5114/ninp.2013.38223 [10] Parkinson's disease. OTvest. (2019, December 14). Retrieved December 5, 2021, from <https://otvest.com/parkinsons-disease/>. [11] U-step neuro (standard). UStep. (2021, October 11). Retrieved December 5, 2021, from [https://www.ustep.com/product/standard-model/?attribute\\_size=Standard%2B%285%E2%80%99%E2%80%9D-6%E2%80%991%E2%80%9D%2Btail%29&attribute\\_cueing-module=Without%2BCueing%2BModule&gclid=Cj0KCQiA47GNBDrARIsAKfZ2rDq-b5jFoH0qr5rc3AV-Mjga1EEj6oQe35r7H09GeTF2SsGiOYdq0aApH-EALw\\_wcb](https://www.ustep.com/product/standard-model/?attribute_size=Standard%2B%285%E2%80%99%E2%80%9D-6%E2%80%991%E2%80%9D%2Btail%29&attribute_cueing-module=Without%2BCueing%2BModule&gclid=Cj0KCQiA47GNBDrARIsAKfZ2rDq-b5jFoH0qr5rc3AV-Mjga1EEj6oQe35r7H09GeTF2SsGiOYdq0aApH-EALw_wcb).