WEARABLE DEVICES TO IMPROVE SPEECH OUTCOMES IN INDIVIDUALS WITH PARKINSON'S DISEASE: A SYSTEMATIC REVIEW

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INTRODUCTION

- Carry over effects of speech outcomes from the clinical setting into everyday life may be challenging for many individuals with (Parkinson's disease) PD.
- Wearable devices are emerging as an alternate option to serve as an assistive device in conjunction with speech therapy to improve speech outcomes.
- Currently available devices utilize different principles to provide biofeedback including Lombard effect, tactile vibrations, and altered auditory feedback.
- The effectiveness of such devices on speech outcomes in individuals with PD are unclear, indicating the need for a systematic review of the existing literature.

OBJECTIVE

To systematically review the evidence for wearable assistive devices that utilize biofeedback principle to improve speech outcomes in individuals with PD.

METHODS

- Our clinical question was based on the PICO (Population, Intervention, Comparison, Outcome) Model : What is the evidence for the use of currently available wearable devices that provide biofeedback to improve speech characteristics in individuals with PD?
- Search terms: "Biofeedback, Assistive devices, Speech Amplification devices, currently available Wearable devices, Altered Auditory Feedback, Tactile feedback, Visual feedback, Speech intelligibility, Speech rate, Parkinson's disease, Vocal loudness and Lombard effect."
- Inclusionary criteria: articles published in the English language since the year 2000, participants with PD with and without DBS, devices that are available in the market, speech outcome measures, and level of evidence based on the criteria defined by Oxford Centre for Evidence Based Medicine (OCEBM) Levels of Evidence Working Group (2011). Based on these criteria, six articles with five devices were identified for further review. Devices (e.g. Vocalog) that did not study speech outcomes were not included.

CONCLUSION

- The primary advantage of wearable devices is to allow assessment of speech in real life environment. Only 3 out of 6 studies measured data outside of the clinic.
- Most devices provide 1.5-3 dB improvement in vocal intensity while LSVT LOUD has shown to provide in-clinic increase from 5- >10 dB
- Level of evidence was 2b (Individual cohort study or low quality randomized controlled trials) for all 6 studies.
- SpeechVive is relatively more studied compared to other devices. However, only one out of three SpeechVive studies used conversation stimuli as opposed to sentence production task but had a small sample size. Long-term effects in real life environment are not known.
- Overall, limited number of studies on speech outcomes and small sample sizes suggest the need for more evidence on the benefit of wearable devices in PD population.

RESULTS

Device	Feedback type and frequency	Number of subjects with PD	Speech outcome measure and Task	Results	Study Criticisms
SpeechVive™ Richardson, K., Sussman,J.E., Stathopoulos, T.,& Huber, J. E. (2014)	-Multitalker babble noise to one ear activated when speaking at a pre-set level – Noise amplitude was adjusted to elicit 3 dB above each participant's SPL in quiet. -Noise amplitude adjusted bi-weekly - Eight weeks of feedback; 2-8 hours per day and 30 min of oral reading 5 days per week	10	-Vocal intensity (measured pre-treatment, immediately post treatment and 4 weeks after post treatment at home and clinic) -18 sentences which included a carrier phrase (It's a again) and words with voiceless consonants	-Significant session effect with 2.5 dB Mean SPL - Effects not retained. Mean SPL decrease of 2.53 dB after 4 weeks.	- Stimuli limited to sentence production and did not use conversation - Small sample size -No mention of how much data was collected at home vs. clinic. Background noise differs in clinic and at home and this may have influenced the results.
Stathopoulos, E. T., Huber, J. E., Richardson, K., Kamphaus, J., DeCicco, D., Darling, M., Fulcher, K., & Sussman, J. E. (2014)	-Multitalker babble noise to one ear activated when speaking at a pre-set level - Noise amplitude was adjusted to elicit 3 dB above each participant's SPL in quiet.	33	Natural connected speech Measured in clinic	-Significant 2 dB SPL increase with SpeechVive in 26/33 individuals	-Data collected in one session - Mean baseline vocal intensity was 79.1 dB SPL which is high for individuals with PD
Matheron, D., Stathopoulos, E. T., Huber, J. E., & Sussman, J. E. (2017)	Multitalker babble noise to one ear activated when speaking at a pre-set level - Noise amplitude was adjusted to elicit 3-5 dB above each participant's SPL in quiet.	42 with PD; 20 controls	Vocal intensity In a sentence "buy pop or pop a papa"	-Mean SPL in quiet was 94.1 dB for controls and 95.6 dB for PD group (no statistical difference) -Speech in noise resulted in a significant gain of 2.59 dB for PD group and 1.88 dB for controls.	-Unnatural sentence production task -Limited to one session
Voxlog Schalling, E., Gustafsson, J., Ternström, S., Wilén, F. B., & Södersten, M. (2013)	Vibrotactile feedback for 3-7 days (23.3-67.8 hours)	6	Vocal intensity in Spontaneous speech in and outside the clinic	- Statistically significant 1.5 dB increase in SPL with vibrotactile feedback compared to baseline	-Small sample size -data collected varied between 1-7 days -1.5 dB improvement in dB SPL with feedback may not be clinically significant - The 1.5 dB benefit was lost when feedback removed -Baseline mean dB SPL for subjects itself was 78.2dB which is high for PD individuals
Small talk and school DAF Lowit, A., Dobinson, C., Timmins, C., Howell, P., & Kröger, B. (2010).	Altered Auditory Feedback (AAF) - with 3 feedback conditions: no feedback, DAF (150ms delay), and FSF (1/2 octave upward shift). 1x weekly for 50-60 minutes for 6 weeks.	10	Speech Rate (SR) for reading and Speech Intelligibility (SI) in reading and monologue	-No significant difference in either SR or SI for traditional speech therapy and with AAF - Some individuals benefitted	-Small talk has small buttons and dials which was found to be difficult for PD patients with fine motor problems to maneuver -Small sample size
Speech Easy Wang, E. Q., Metman, L. V., & Bernard, B. A. (2008)	-AAF: DAF- 50-200ms; FAF-500Hz; unilateral-but connected to the computer. -Six testing conditions: 2 baseline, 2 placebo, and 2 feedback -One session of feedback in clinic	9	SI and SR in reading, controlled monologue, picture description, and 30 s conversation sample.	-SI improved for monologue under AAF but not for reading - SR was unchanged for monologue but statistically significant for reading	-No significant difference in SI and SR between placebo and AAF conditions suggesting that the device benefits are equivalent to a placebo effect - One session of feedback only. Long term effects of the device not known. - Effects of device in real life environment not known -Small sample size

References available upon request. Authors would like to thank Kelli Morgan and Lindsay Draper (ETSU) for their help with this study.