

Title: Wearable Technology to Facilitate Telerehabilitation for Service Members and Veterans with Lower Limb Loss

Congress Theme: "From Rehab to Prehab – Putting Soldiers back on Track"

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Summary

"Service Members (SM) and Veterans with lower limb amputation (LLA) are at a high risk for developing secondary co-morbidities such as joint pain, osteoarthritis, chronic low back pain, and cardiovascular disease [1,2]. To mitigate these secondary comorbidities, optimize long-term function, and increase quality of life, effective rehabilitation and innovative life-long care is essential. Telerehabilitation has recently demonstrated to be a useful method of healthcare delivery, particularly benefitting individuals with physical limitations who are unable to attend outpatient physical therapy, such as patients following LLA [3]. Wearable technology, such as mobile sensors, has the potential to augment current telerehabilitation practice and improve home walking and exercise compliance for those with LLA. Therefore, could this technology be used to provide "booster" prosthetic training to improve or reinforce current mobility and prosthetic use, promote an active, healthy lifestyles and mitigate adverse secondary comorbidities? To address this question, the Department of Defense (DoD) and Veterans supported the development of a program through the Joint Incentive Fund called the Mobile Device Outcomes-based Rehabilitation Program (MDORP). The MDORP is a comprehensive mobile rehabilitation program that is clinician-guided and incorporates the use of a mobile sensor system called the Rehabilitative Lower Limb Orthopedic Assistive Device (ReLOAD). The ReLOAD system (Figure 1) provides: (1) assessment of walking quality at home and in the community for people with LLA, (2) real-time auditory feedback to correct the most prominent gait deviations, and (3) automatic prescription of home exercises that target balance and strength impairments related to their most prominent gait deviation [4,5]. The primary objective of the study was to determine if the 8-week MDORP improved strength, mobility, and gait quality in SMs and Veterans with LLA.

Methods and Results: Forty SMs and Veterans with LLA between the ages of 20-80 who were current prosthesis users with major unilateral or bilateral LLA below, at or above the knee completed the 8-week intervention. Baseline data collection was performed which included administration of patient reported and performance-based outcome measures. Participants received standardized functional prosthetic gait training (SFPGT) and were taught how to perform the home exercises. Lastly, they received training to use ReLOAD prior to deployment for home use. The physical therapists performed home visits every two weeks to verify the participants were using the ReLOAD system properly, to review the SFPGT and home exercises, and to assess the presence of new health related issues.

Participants were encouraged to perform home walks and exercises 3-times per week. Participants returned at 8-weeks to complete follow-up data collection. Significant improvements in hip extensor strength, basic and high-level mobility, musculoskeletal endurance, and gait quality ($p < 0.05$) were found at the completion of the 8-week intervention. As well, the majority of participants reported that they would use the system again for home rehabilitation (65%) and that auditory biofeedback helped them walk better (59%). Participants also suggested that future work should include a greater variety of exercise options and the use of smart phones for the ReLOAD application in addition to the iPad tablet.

Conclusion: Preliminary MDORP results are promising in its ability to improve basic and high-level mobility, lower limb strength, and gait quality in a group of SMs and Veterans with LLA. In addition, “booster” prosthetic training may be justified in an effort help maintain an active lifestyle, promote prosthetic use, and mitigate secondary comorbidities. Lastly, the participants provided positive and constructive feedback that offered the research team the opportunity to expand MDORP to multiple VA hospitals, as to examine the usability among clinicians and more than 300 SMs and Veterans with LLA.

References

1. Robbins CB, Vreeman DJ, Sothmann MS, Wilson SL, Oldridge NB. A review of the long-term health outcomes associated with war-related amputation. *Mil Med.* 2009;174(6):588-92.
2. Gailey R, Allen K, Castles J, Kucharik J, Roeder M. Review of secondary physical conditions associated with lower-limb amputation and long-term prosthesis use. *J Rehabil Res Dev.* 2008;45(1):15-29.
3. Burger H, Rudel D, Balorda Z, et al: Telerehabilitation of patients after trans-tibial amputation. *Arch Phys Med Rehabil* 2016; 97(10): e127-e127.
4. Gaunard I, Gailey R, Symsack A, Springer B, Clemens S, Lucarevic J, Kristal A, Bennett C, Isaacson B, Agrawal V, Applegate B, Pasquina P. The Utility of the DoD/VA Mobile Device Outcomes Based Rehabilitation Program (MDORP) for Higher Functioning Service Members and Veterans with Lower Limb Amputation. *Military Medicine.* Volume 185, Issue Supplement_1, January-February 2020, 480-489.
5. Symsack A, Gaunard I, Thaper A, Springer B, Bennett C, Clemens S, Lucarevic J, Kristal A, Sumner M, Isaacson B, Pasquina P, Gailey R. Usability Assessment of the Rehabilitative Lower Limb Orthopedic Accommodating Device (ReLOAD) by Service Members and Veterans with Lower Limb Loss. *Mil Med.* 2021 Feb 26; 186 (3-4): 379-386.Summary”