Assessing the Effectiveness of Virtual Reality for Power Wheelchair Driving Training

Joseph Aguirre MS-IV[1], Christian Roehmer, MD[2], Jesse Day, MD[3], Deepan Kamaraj, MD[4], Brooklyn Waters[5], Margaret Pickering[5], Rory Cooper, PhD[3,4], Brad E. Dicianno, MD[3,4]

[1]Lake Erie College of Osteopathic Medicine; [2]Vanderbilt University, Department of Physical Medicine and Rehabilitation; [3]University of Pittsburgh School of Medicine, Department of Physical Medicine and Rehabilitation; [4]Human Engineering Research Laboratories, VA Pittsburgh Healthcare System; [5]MTech Games

Grant Support: Promobilia Foundation

INTRODUCTION

- Over 19 million people worldwide use wheelchairs, with approximately 14-30% of wheelchair users currently using electric powered wheelchairs (PWCs)
- Many rehabilitation settings lack the time and personnel to provide adequate training for PWC driving
- Virtual reality (VR) has been explored as a way to provide additional training in the use of PWCs
- Collaborative work being conducted at the Human Engineering Research Laboratories (HERL) and MTech Games has resulted in a validated PWC driving assessment tool that has been translated into a VR platform

OBJECTIVES

- Evaluate the impact of using a virtual reality (VR) training system on powered wheelchair driving skills

MATERIALS & METHODS

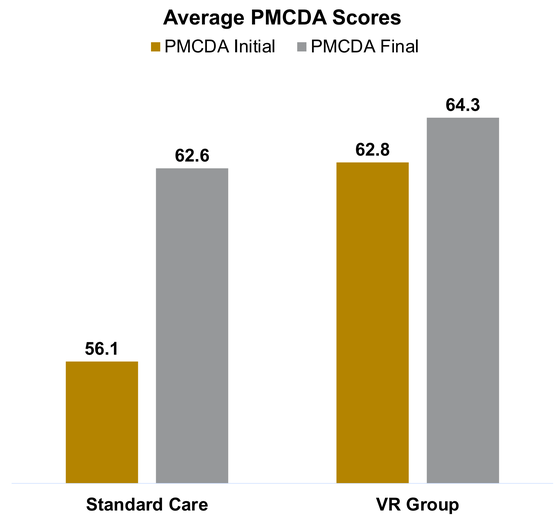
- Recruitment occurred at the inpatient and outpatient rehabilitation facilities at the UPMC Rehabilitation Institute and through community outreach efforts with disability organizations.
- Participants were randomized into a VR group or a standard care group
  - The standard training group received four in-person wheelchair skills training sessions by a certified therapist using the Wheelchair Skills Training Program (WSTP) program.
  - The VR group received four training sessions using Wheelchair Trainer in Oculus Rift.
- NASA TLX was used to evaluate participants' perception of the Virtual Reality system.
- A Simulator Sickness Questionnaire (SSQ) measured symptoms experienced while using the VR system.

RESULTS

Standard Care Group	Initial PMCDA	Final PMCDA	Sessions Completed
Participant 1	57	65	4
Participant 2	47	56	3
Participant 3	55	61	2
Participant 4	54	62	3
Participant 5	51	62	4
Participant 6	62	66	4
Participant 7	62	65	3
Participant 8	61	64	1

VR Group	Initial PMCDA	Final PMCDA	Sessions Completed
Participant 1	65	66	4
Participant 2	61	62	1
Participant 3	64	65	3
Participant 4	61	64	1

RESULTS



- Ages ranged from 27 to 84 (average 64.2 years, SD=15.8)
- Standard care group
  - Median of 3 sessions (range 1-4)
  - Average baseline PMCDA score of 56.1 (+/- 5.5 SD)
  - Average incremental increase of 2.3 (+/- 0.9 SD) points per session (effect size, *r=.59)*
- VR training group
  - Median of 2 sessions (range 1-4)
  - Average baseline PMCDA score of 62.8 (+/- 2.1 SD)
  - Average incremental increase of 1.2 (+/- 1.3 SD) points per session (effect size, *r=.38)*

NASA TLX	AVERAGE	STD DEV
MENTAL	69.3	+/- 31.3
PHYSICAL	46.5	+/- 35.5
TEMPORAL	40.3	+/- 40.1
PERFORMANCE	60.5	+/- 23.9
EFFORT	68.3	+/- 33.7
FRUSTRATION	55.0	+/- 37.7

CONCLUSIONS

- VR and standard training resulted in incremental and clinically meaningful improvements in driving skill with each session attended
- Many participants were not able to complete multiple training sessions due to transportation issues for individuals with mobility impairments
  - Highlights need for training systems like VR
- Future work will evaluate the use of VR in larger samples and as a home-based rehabilitation intervention

REFERENCES

1. International Society of Wheelchair Professionals. http://www.wheelchairnet.org
2. Karmarkar AM, Collins DM, Wichman T, et al. Prosthesis and wheelchair use in veterans with lower-limb amputation. *J Rehabil Res Dev.* 2009;46(5):567-576
3. Salatin B, Teodorski E, Ding D, Cooper RA. A survey of outdoor powered wheelchair driving. Paper presented at Annual Conference of RESNA. June 26-30, 2010; Las Vegas, NV.
4. Zanca JM, Dijkers MP, Hsieh CH, et al. Group therapy utilization in inpatient spinal cord injury rehabilitation. *Archives of physical medicine and rehabilitation.* 2013;94(4 Suppl):S145-153.
5. Taylor-Schroeder S, LaBarbera J, McDowell S, et al. The SCIRehab project: treatment time spent in SCI rehabilitation. Physical therapy treatment time during inpatient spinal cord injury rehabilitation. *The journal of spinal cord medicine.* 2011;34(2):149-161
6. Nunnerley J, Gupta S, Snell D, King M. Training wheelchair navigation in immersive virtual environments for patients with spinal cord injury - end-user input to design an effective system. *Disability and rehabilitation Assistive technology.* 2017;12(4):417-423.