THE EFFECT OF WHOLE BODY VIBRATION ON POWER WHEELCHAIR MOBILITY: A FOCUS GROUP

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ABSTRACT

Vibration, shock (single event and repeated), and motion have a significant effect on the health and quality of life for individuals who utilize a wheelchair for mobility. The purpose was to characterize the effect of whole-body vibration, impact and motion from the perspective of the individual utilizing a power wheelchair and the rehabilitation professionals. We conducted four focus groups: two with individuals with disabilities who utilize power wheelchairs, and two with rehabilitation professionals who recommend power wheelchairs. The fifteen consumers and nine rehabilitation professionals identified nine themes, with overlap between the groups on five of the themes. The consumers easily described their mobility related experiences in terms of the obstacles and surfaces they encounter and the effect on their everyday life. The rehabilitation professionals had difficulty providing detailed examples given they did not have personal experience utilizing the wheelchair, however they provided specific recommendations for future wheelchair development and research activities. This information can be used to guide future research and development activities.

INTRODUCTION

As of 2005, more than 3.26 million Americans have a disability that requires wheeled mobility equipment(LaPlante & Kaye, 2010). Vibration, shock (single event and repeated), and motion have a significant effect on the health and quality of life for individuals who utilize a wheelchair for mobility. Vibration and shock can cause back pain and injury, which has been well documented in the literature. (Griffin, 1975, 1990; Kitazaki & Griffin, 1998; Paschold & Mayton, 2011; Wilder, Magnusson, Fenwick, & Pope, 1994). The biomechanics of low back injury, have many implications for the possible progression of injuries. They indicate that the injury process need not only be associated with very high loads but also with low loads that are repeated or sustained. Vibrations and shock can compromise the stability of the spine, resulting in vulnerability to injury during the performance of an otherwise safe or low risk task. For an individual who uses a wheelchair and is exposed to daily vibration and shock, performing a routine task such as a transfer or reaching and lifting an object, could cause a back injury. Therefore, the purpose of this study is to characterize the effect of whole-body vibration, impact and motion from the perspective of the individual utilizing a power wheelchair and the rehabilitation professionals who make power wheelchair recommendations.

METHODS

Research Design

A qualitative research design based on focus groups was utilized to identify themes as they relate to the utilization of power wheelchairs at home and in the community. We conducted four focus groups. One set of two focus groups included individuals with disabilities who utilize power wheelchairs. The other set of two focus groups included rehabilitation professionals who recommend power wheelchairs. The study was approved by The Ohio State University Institutional Review Board.

The consumer focus group included individuals with a disability who utilize a power wheelchair as his/her primary mode of mobility. The clinical focus group included rehabilitation professionals with experience providing seating and mobility (aka wheelchair) services to individuals with disabilities. The final allocation of participations was based on a convenience sample of the above-mentioned groups.

Detailed study procedures

The qualitative research was based on a focus group design. The focus group meeting was lead by 2 facilitators: a lead facilitator with extensive experience in focus group activities, a secondary facilitator who is a subject matter expert in the field. A scribe was also present to document the discussions on flip charts for review during the meeting by the attendees. The focus group meeting was divided into 2 activities: the first focusing on the surfaces and obstacles individuals experience in day-to-day activities, the second focusing on the functional and non-functional features on current and future power wheelchairs that directly affect vibration, shock and motion.

Activity 1 - Consumers

Participants identify the types of surfaces and obstacles that they have traversed when using their power wheelchair.

The Human, Activity, Assistive Technology, and Context (HAAT) model was utilized to engage participants in describing the process for traversing surfaces and obstacles (Cook & Polgar, J. M., 2008). Specifically, the discussion focused on when the obstacles occur, how often they occurs, what devices they use to traverse obstacles, and the strategies they use to traverse the obstacles. Finally, the activities explored the amount of pain and discomfort experienced when utilizing the power wheelchair,

Activity 1 – Clinicians

The focus group discussions were similar to those for consumers, but from the perspective of the rehabilitation professional, given their experience with multiple consumers. An additional area of discussion included the rehabilitation professionals' knowledge in the terms of current evidence-based practice for the reduction of vibration, shock and motion when utilizing a power wheelchair.

Activity 2 - Both

Participants identified the objectives, constraints and metrics of a device that could decrease the transmission of vibration, shock and motion to individuals using a power wheelchair. This included both functional (e.g. what does the device need to do?) and non-functional (e.g. look and feel, performance and usability) requirements.

Data Analysis

The data analysis began during the focus group meetings, as the participants identified key items that were recorded by the scribe on the flip-charts. This methodology recognizes the participants as subject matter experts, and initiates the process of identifying the key themes as it relates to whole-body vibration, impact and motion when utilizing a power wheelchair. The second level of analysis included reviewing the audio/video to validate the key themes identified by the participants. Finally, each participant was contacted for a phone interview to validate the final themes that were identified. The phone interview was critical given that not all themes were identified by the respective groups.

RESULTS

Fifteen consumers provided informed consent to participate in the study (10 men, 5 women) with a mean age of 43.9 years (s.d. 14.6, range 23-75). In terms of their primary mode of mobility, all used power wheelchairs, of which thirteen had powered seating. Seven individuals had a cervical spinal cord injury, and the remainder had a primary diagnosis of one of the following: paraplegia, quadrilateral amputation, postpolio syndrome, arthrogyposis, multiple sclerosis and stroke.

Nine rehabilitation professionals (3 PT, 3 OT, 3 Rehab Suppliers) with experience in seating and mobility provided consent to participate in the study. There were 5 men and 4 women with a mean age of 44.4 years (s.d. 9.1, range 30-58). The participants had been practicing as rehabilitation professionals on average for 15.6 years (s.d. 8.8) and had on average 11.3 years (s.d. 6.3) of seating and mobility experience. Five participants had the Assistive Technology Professional certification and one had the Seating and Mobility Specialist certification.

Themes

The consumers and rehabilitation professionals each identified seven themes. Though there was some overlap, each group provided a unique perspective on each theme.

Consumer Themes

Surfaces and Obstacles. The consumers identified over thirty different surfaces and obstacles that they traversed while using their power wheelchair. Furthermore, they highlighted specific obstacles and surfaces that caused shocks, vibrations and motion within their power wheelchairs. The identified shocks include uneven grass, heaved and cracked sidewalk, transitions and thresholds. The identified surfaces that cause vibration include grass, gravel, truncated domes, cobblestone and cracked sidewalks. The identified surfaces that caused motion within the seating system, includes the same surfaces and obstacles that cause shocks and vibrations.

Effect on Travel. The surfaces and obstacles have a significant effect on their ability to travel. The surfaces and obstacles have an affect on their pre-trip planning, on the actual trip (e.g. lengthen trip, lose control of wheelchair), and on post trip activities (e.g. fatigue, repositioning in seating system).

Effect on the Person. Traversing the surfaces and obstacles has an effect on the person in terms of increased pain, discomfort, numbness and apprehension. The surfaces and obstacle that were identified as having the largest effect were brick, truncated domes, gravel, broken down/crumbling sidewalk, and any unanticipated / unexpected obstacles.

Future Wheelchairs. Future wheelchairs should focus on minimizing shock, vibration and motion. The most important feature identified by the participants was a suspension system. The system should be placed between the seat and the base, the tires and the base, and in the tires. The consumer should be able to turn it on and off as needed. An air suspension seat used on trucks and buses was given as an example of a suspension system between the base and the seating system.

Increased Participation. A redesigned wheelchair would decrease pain, discomfort, fatigue, spasms and apprehension. Furthermore it would lead to less medications and increased safety, which would allow them to do more things and go more places.

Advice to Manufactures. Engineers should live in the wheelchair in order to fully experience what it is like to use a wheelchair in the community. Furthermore, individuals with disabilities should fully participate in the design and development of wheelchairs.

Information. The participants have a need for more information in order to make an informed decision about the future wheelchair. The want to know about the dimensions, features, performance, adjustability, durability, and maintenance schedule.

Rehabilitation Professionals Themes

Surfaces and Obstacles. The clinicians identified over forty different surfaces and obstacles that individuals traversed while using a power wheelchair. Similar to the consumers, they identified obstacles and surfaces that caused shocks, vibrations and motion within their power wheelchairs. The identified shocks include driveway edges, thresholds, ramps, bricks, potholes and curbs. The identified surfaces that cause vibration include gravel, grass, cobblestone, grates, bricks, pavers, decking. The identified surfaces that caused motion within the seating system, includes the same surfaces and obstacles that cause shocks and vibrations.

Effect on the Person. Traversing the surfaces and obstacles has an effect on the person in terms of increased pain, discomfort, fatigue, fear and apprehension. These are observed when traveling over thresholds, bricks, pot holes pavers, decking and curbs.

Individual. The clinicians identified multiple diagnoses that are most often affected by vibration, shock and motion. These include SMA, MD, MS, ALS, SCI, CP, spina bifida, stroke, lower extremity amputations, Friedreich's ataxia and brain injury. The clinicians also identified individuals aging with a disability or living in a rural setting. Regardless of diagnoses, individuals with a startle reflex, spasticity, and hyper/hypo tonicity or greatly affected.

Current Wheelchair. The features of current wheelchairs that have the greatest effect on the transmission of shock, vibration and motion to the person include the suspension system, the seat frame mounting hardware (i.e. single post, 4-post), cushion, back support, armrests, legrests and headrest, the size and properties of the drive wheels and casters wheels, and the programming.

Future Wheelchairs. Future wheelchairs should focus on minimizing shock, vibration and motion. The clinicians highlighted a variety of suspension systems, with the ability to tune the system to the unique requirements of the individual, and automatically adjust the suspension based on the environment. They also highlighted a power seating system (i.e. tilt, elevate, recline, elevating legrests), that automatically adjusted based on the environment. They recommended looking at industries outside wheelchairs for potential solutions, specifically, the automotive, trucking and agriculture industries.

Advice to Manufactures. The advice to manufacturers include involving the consumer from the start-to-end of the development process, thinking outside the box, and focusing on educating consumers. Collaborations with consumer, industry, and academic partners are critical for future success.

Information. The participants have a need for more information in order to make an informed decision about the future wheelchair. The want to know about the dimensions, features, performance, adjustability, durability, and maintenance schedule. They want to know the cost of the system and if third-party payers will pay for the system. The want to know who was involved in the design process (i.e. consumers, clinicians, engineers). They want research studies examining the effectiveness of the wheelchair as they indicated this was a critical part of evidence based practice. They emphasized the need for the consumers' perspective through reviews and ratings. Finally they want to get this information in real-time through web 2.0 mediums on multiple devices (e.g. smart phone, tablet, computer).

DISCUSSION

The purpose of this study was to characterize the effect of whole-body vibration, impact and motion from the perspective of the individual utilizing a power wheelchair and the rehabilitation professionals who make power wheelchair recommendations. The focus group analysis identified multiple themes from the consumers' perspective and the rehabilitation professionals' perspective. The consumers were very focused, and had no problem describing their experiences in terms of the obstacles and surfaces they encountered and the effect of the vibration, shock and motion on their everyday life. The rehabilitation professionals were not as focused, and provided greater breadth when describing the themes. For future wheelchair development, both groups want to have a greater role in product development, and want more information from the manufacturer. Furthermore, clinicians want more research data to document the need for the equipment. Limitations of this study include the small sample size. The information obtained in the study can be used for future research and development activities related to whole-body vibration, motion and shock as experienced by individuals who utilize a power wheelchair.

DISCUSSION

The focus group analysis identified multiple themes from the consumers' perspective and the rehabilitation professionals' perspective. The consumers were very focused, and easily describe their experiences in terms of

the obstacles and surfaces they encountered and the effect of the vibration, shock and motion on their everyday life. The rehabilitation professionals were not as focused, and had difficulty providing detailed examples given they did not have personal experience utilizing the wheelchair. The research professionals were able to provide detailed feedback on current wheelchairs, and advice for the development of future wheelchairs. For future wheelchair development, both groups want to have a greater role in product development, and want more information from the manufacturer. Furthermore, clinicians want more research data to document the need for the equipment. Limitations of this study include the small sample size. The information obtained in the study can be used for future research and development activities related to whole-body vibration, motion and shock as experienced by individuals who utilize a power wheelchair.

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REFERENCES

Cook, A. M., & Polgar, J. M., J. M. (2008). Framework for Assistive Technologies. In *Cook & Hussey's Assistive Technologies: Principles and Practice* (3rd ed., pp. 34–53). St: Mosby, Inc.

Griffin, M. J. (1975). Vertical vibration of seated subjects: effects of posture, vibration level, and frequency. *Aviation, Space, and Environmental Medicine*, *46*(3), 269–276.

Griffin, M. J. (1990). *Handbook of Human Vibration*. San Diego: Academic Press, Inc.

Kitazaki, S., & Griffin, M. J. (1998). Resonance behaviour of the seated human body and effects of posture. *Journal of Biomechanics*, *31*(2), 143–149.

LaPlante, M. P., & Kaye, H. S. (2010). Demographics and trends in wheeled mobility equipment use and accessibility in the community. *Assist Technol*, *22*(1), 3–17; quiz 19.

Paschold, H. W., & Mayton, A. G. (2011). Whole-Body Vibration. *Professional Safety*, *56*(4), 30–34.

Wilder, D., Magnusson, M. L., Fenwick, J., & Pope, M. (1994). The effect of posture and seat suspension design on discomfort and back muscle fatigue during simulated truck driving. *Applied Ergonomics*, *25*(2), 66–76.