Wheelchair Securement System Testing in a Pittsburgh Port Authority Transit Bus

Linda van Roosmalen, Mike Turkovich, Douglas Hobson, Erik Porach, Patricia Karg, Ana Allegretti

Rehabilitation Engineering Research Center on Wheelchair Transportation Safety

Department of Rehabilitation Science and Technology, University of Pittsburgh

The RERC on Wheelchair Transportation Safety recently performed a study evaluating three wheelchair securement systems on a large transit bus. These systems included a state-of-the-art 4-point tie down system (Q'Straint), a prototype rear-facing wheelchair passenger station (Pitt & Q'Straint) and a prototype automated docking system (Pitt & Kinedyne) (Figure 1). A 44-passenger Pittsburgh Port Authority Transit bus was overhauled and the securement systems were installed.

Figure 1 (left): Power wheelchair in the Rear-Facing wheelchair passenger station and Scooter in the Automated Docking System
Figure 2 (right): An unsecured manual wheelchair swinging into the isle during a quick turn of the vehicle

First, emergency bus maneuvers consisting of a hard brake from 20-0 mph and sharp left and right turns were performed. Each securement system was also evaluated for compliance with federal requirements for wheelchair securement using 50th percentile ISO test dummies placed in three different mobility aids: an Amigo scooter, a Quickie 2 manual wheelchair, and an Invacare TDX-SP power wheelchair. Maximum acceleration of the vehicle and excursion of the wheelchair in each securement system were recorded during turning, braking and normal driving. All systems passed the driving tests with flying colors; wheelchair movement was less than 2" during all test scenarios. To create some excitement among the investigators, the wheeled mobility devices were then subjected to emergency bus maneuvers without any securement systems in place. The results clearly showed the need for the securement systems, as wheelchairs slid across the bus and crashed into the sides of the bus (Figure 2).

In addition to compliance testing of the securement systems, seven bus drivers and twenty manual/power wheelchair- and scooter-seated individuals gave their user feedback on each securement system. Our group of 6 investigators was stationed at the United Cerebral Palsy building in Oakland where different PAT bus drivers picked up study participants. Each study participant was safely transferred by Dr. Allegretti, an occupational therapist, into a matching test wheelchair/scooter and instructed to use the wheelchair-mounted safety belt (prototype provided by BodyPoint). Then participants were asked to use and evaluate each securement station on the bus during a test route (Figure 3).

Figure 3: Study participant is evaluating the rear-facing wheelchair passenger station

The bus test route was selected to incorporate steep uphill and downhill sections (cardiac hill!), as well as numerous left and right turns and stops. After each ride, study participants were asked to answer questions on the safety, usability and comfort of the securement system. A summary questionnaire was conducted among wheelchair users and bus drivers and went in-depth on the preferred securement system and what could be changed to make the system even better.

In the next few months the investigators will be designing an improved securement system, or optimizing existing securement systems to maximize safety, comfort and usability for both wheelchair users and bus drivers. For additional information, please contact the PI. Linda van Roosmalen, at Lvanroos@pitt.edu or at (412) 586-6911.

The Rehabilitation Engineering Research Center on Wheelchair Transportation Safety is funded by the Dept. of Education, National Institutes on Disability and Rehabilitation Research.