

Examination of Wheelchair Tiedown and Occupant Restraint Systems (WTORS): Use and Effect on Motor Vehicle Related Injuries

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ABSTRACT

This study examined the use of wheelchair tiedown and occupant restraint systems (WTORS) by wheelchair users in motor vehicle (MV) transportation, as well as the relationship of WTORS use and the occurrence of MV related injuries. A sample of 336 wheelchair users were surveyed to identify patterns and practices when using MV transportation. The results showed that few individuals complied with the complete use of WTORS when seated in a MV. Also, there was no cross-sectional relationship between the use of WTORS and self-reported MV related injuries. These findings suggest that WTORS compliance is low, particularly among private vehicle passengers. Future prospective studies are necessary to quantify the cause and effect link between WTORS and the prevention of MV injuries.

KEYWORDS

Wheelchair, Transportation, Wheelchair Tiedown and Occupant Restraint Systems, Injury

BACKGROUND

Due to the passage of several pieces of legislation, including the Americans with Disabilities Act (ADA), more employment, recreational and community centered opportunities are being presented to the estimated 2,200,000 Americans who use wheeled mobility devices¹. The use of MV transportation has likely increased among wheelchair users to meet these opportunities. While many wheelchair users are able to transfer to the vehicle seat, some remain seated in the wheelchair while traveling in a motor vehicle. It is important that these individuals are afforded the same level of protection from injury, as the general population.

The Society of Automotive Engineers (SAE) Recommended Practices J2249, provides best practice guidelines for the design, testing and performance requirements for WTORS. SAE J2249 states that a person seated in a wheelchair, should utilize both a wheelchair tiedown device (e.g. docking, four-point strap), designed to secure the wheelchair in a forward facing position; in conjunction with an occupant restraint that consists of both a pelvic and upper torso belt, anchored directly to the vehicle or to the components of the wheelchair tiedown device². While this standard is now well established, very little is known about the extent to which WTORS are actually being applied and used in the wheelchair using population. Nor have studies examined the link between injury prevention and WTORS.

RESEARCH QUESTION

The purpose of this paper is to describe how wheelchair users, in various forms of MV transportation, use WTORS; as well as the cross-sectional relationship between the use of these devices and the occurrence of motor vehicle related injuries.

METHODS

Wheelchair users were identified from several national and state-based disability organizations, as well as wide spread advertising, and invited to participate in this study. Eligibility criteria required that the individual 1) use a wheelchair as their primary means of mobility and 2) had used their wheelchair as a seat in a motor vehicle at least once in the last month. A total of 336 wheelchair users met the eligibility requirements and completed, through mail, a 12 page survey. The survey consisted of questions regarding demographic characteristics, wheelchair type, MV transportation, WTORS use and the occurrence of an

injury while using a motor vehicle within the past 3 years. All subjects provided informed consent. Descriptive statistics, chi-square and t-test analysis was completed using SPSS statistical software.

RESULTS

The sample population (n=336) was 46.7% male, with a mean age of $42.7 \pm (14.6)$ years. 66.7% of the population reported using a power wheelchair, while 33.3% reported using a manual wheelchair as their primary means of mobility. In regard to disability type, cerebral palsy was the most reported disability with 21.6% of the population, followed by quadriplegia (20.1%), multiple sclerosis (11.1%), paraplegia (9.0%), muscular dystrophy (8.4%), and poliomyelitis/post polio syndrome (6.9%).

Primary transportation use (calculated by weekly mileage) was determined for each subject. The data demonstrated that 72.2% of the sample population usually traveled in private vehicles, with 50.0% traveling as passengers and 22.2% as drivers. Also, 27.8% regularly used public transportation, with 19.3% traveling in paratransit vehicles and 8.5% utilizing mass transit buses.

Insert Table 1 Here: Characteristics of Subjects in Regard to Primary Transportation Mode

The use of complete WTORS, as recommended by SAE J2249, and consisting of a forward facing wheelchair tiedown with a pelvic and upper torso occupant restraint, was examined. Overall, individuals reported using complete WTORS $43.8\% \pm (47.3)$ of the time, while traveling in any mode of transportation. In specific regard to each mode, the following use of WTORS was shown: *Driver*: 63.0% complete and 37.0% incomplete, *Private Passenger*: 39.9% complete, 43.7% incomplete and 16.4% no use, *Bus Passenger*: 19.0% complete, 45.4% incomplete and 35.6% no use, and *Paratransit Passenger*: 48.6% complete, 43.1% incomplete and 8.3% no use.

Insert Graph 1 Here: Reported Use of WTORS

Subject involvement in either a MV crash (passenger or driver) or a non-crash incident resulting in an injury was also documented in this study. A non-crash incident was defined as sudden vehicle maneuvering, such as a sudden stop or turn, that resulted in an injury. Overall, 28.7% of the subjects (n=95) reported to being injured while traveling in a motor vehicle. A total of 21 crashes and 105 non-crash incidents were identified as the cause of these injuries.

Further analysis was completed to determine if a cross-sectional relationship existed between the reported use of WTORS and those who were injured while traveling in a motor vehicle. Among subjects reporting a motor vehicle related injury, complete WTORS use was reported $41.7\% \pm (46.7)$ of time. This finding was only slightly lower than that reported by persons who were not injured in a MV related incident. These individuals reported to wearing complete WTORS $45.21\% \pm (47.7)$ of the time. No statistically significant relationship was found.

The relationship between the use of WTORS and the severity of the injury was also of interest. Injury severity was defined by the need to seek medical attention for treatment of the injury. To obtain this information, incident forms, which were designed to gather specific details on the injuries, were used. Within the context of these forms, a total of 85 motor vehicle related injuries, occurring while the person was seated in their wheelchair, were reported in more detail. Overall, 19 required medical attention for the injury. Only 10.5% of these individuals reported to using complete WTORS. However, these findings were similar to that reported by subjects with less severe injuries, where complete WTORS was reported by 8.9%. Again, no significant difference was seen.

Insert Table 2 Here: Relationship of WTORS use to Injuries Requiring Medical Attention

DISCUSSION

Due to the increase use of motor vehicle transportation by wheelchair users and the need to understand how individuals are currently being protected while in a MV, the focus of this paper is to describe the use of WTORS, as well as how these devices effect the occurrence of MV related injuries.

In regard to transportation use, the data demonstrated that private vehicles (Private: 72.2%, Public: 27.8%) are the most common form of transportation used by persons in wheelchairs. Also, it was shown that the use of a recommended, complete WTORS was low, particularly among private vehicle passengers. Overall, these devices were reported as being used only 44% of the time. Within specific transportation modes, the following was low use was seen (Driver: 63.0%, Private Passenger: 39.9%, Mass Transit Bus: 19.0% and Paratransit: 48.6%). These findings hold especially true when compared to the general population. In 2005, The National Highway Traffic Safety Administration reported that safety belt use in the U.S. has reached its highest level, with 82.0% of the population using safety belts³. Efforts through education, to increase compliance may be valuable.

No cross-sectional relationship was observed between WTORS use and MV related injuries. Similar usage of these devices was reported by both those injured and not injured and those requiring medical assistance and not requiring assistance for their injuries. These findings may suggest that while individuals report using WTORS, they may not be using these devices effectively. This study did not gather information to classify the proper use of WTORS. Others have suggested that these devices are uncomfortable, intrusive, not necessary and time consuming, thus increasing the chance of non or improper use^{4,5}. Alternatively, this study examined WTORS and injuries cross-sectionally and cannot demonstrate a cause and effect relationship. Future studies with prospective designs are needed to quantify the reduction in injury risk from WTORS use.

This study reports on the experiences of a convenience sample of 336 individuals and required their recall of specific events across a 3 year period. For these reasons bias may be present in the reporting of WTORS use and injury occurrence. However, responses were received from subjects across the United States, reflecting numerous forms of disabilities. This study indicates that WTORS use is likely to be poor in the overall wheelchair using population. Efforts focused to increasing the proper use of WTORS may be beneficial.

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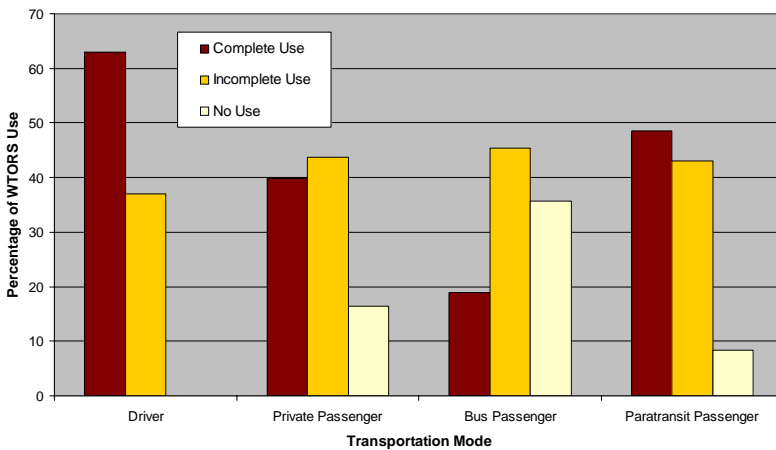
Table 1 Here: Characteristics of Subjects in Regard to Primary Transportation Mode

	Gender (male)	Age (mean yrs.)	WC Type (power)	Seating Position in Vehicle (remain in WC)	Weekly Mileage	Top Disability Types
Primary Driver (n=68)	64.7%	46.06	58.2%	47.7%	160.58	Quad – 32.8% Para – 26.9% MS – 7.5% Polio/Post-polio – 7.5%
Primary Private Passenger (n=153)	40.5%	41.26	69.7%	71.9%	131.88	CP – 24.5% Quad – 23.2% MD – 13.2%
Primary Bus Passenger (n=26)	50.0%	38.04	75.0%	92.0%	52.08	CP – 26.9% MS – 15.4% Quad – 7.7% Spina Bifida – 7.7% Neuro Disorder – 7.7%
Primary Paratransit Passenger (n=59)	44.1%	44.1	60.0%	94.9%	77.83	CP – 28.8% MS – 16.9% MD – 8.5%

Summary Text Description for Table 1: Characteristics of Subjects in Regard to Primary Transportation Mode

Table depicts the characteristics of individuals in each of the four primary transportation modes: “Driver”, “Private Passenger”, “Bus Passenger”, “Paratransit Passenger”, in regard to gender, age, wheelchair type, seating position in vehicle, weekly mileage and disability type.

Graph 1 Here: Reported Use of WTORS



Summary Text Description for Graph 1: Reported Use of WTORS

Graph depicts the use of complete, incomplete and no WTORS use by primary transportation mode. The x-axis shows the transportation mode: “Driver”, “Private Passenger”, “Bus Passenger”, “Paratransit Passenger”, and the y-axis shows the percentage of WTORS use. Graph indicates that Drivers use 63.0% complete WTORS and 37.0% incomplete, Private Passengers use 39.9% complete, 43.7% incomplete and 16.4% no use, Bus Passengers use 19.0% complete, 45.4% incomplete and 35.6% no use, and Paratransit Passengers use 48.6% complete, 43.1% incomplete and 8.3% no use.

Insert Table 2 Here: Relationship of WTORS use to Injuries Requiring Medical Attention

		Complete WTORS Use	Incomplete WTORS Use	No WTORS USE
Medical Attention	Yes (n=19)	10.5%	63.2%	26.3%
	No (n=56)	8.9%	78.6%	12.5%

Summary Text Description for Table 2: Relationship of WTORS use to Injuries Requiring Medical Attention

Table shows the use of WTORS (complete, incomplete and none) by those who required and did not require medical attention due to a MV related injury. No significant differences were seen between the two groups.

*Missing data (n=10) explains the discrepancy in total injuries reported here and in the results