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ORIGINAL RESEARCH ARTICLE

Increases in Wheelchair Breakdowns, Repairs, and Adverse Consequences for People with Traumatic Spinal Cord Injury

ABSTRACT

Worobey L, Oyster M, Nemunaitis G, Cooper R, Boninger ML: Increases in Wheelchair Breakdowns, Repairs, and Adverse Consequences for People with Traumatic Spinal Cord Injury. *Am J Phys Med Rehabil* 2012;91:00–00.

Objective: The aims of this study were to report the current incidence of wheelchair breakdowns, repairs, and consequences and to compare current data with historical data.

Design: A convenience sample survey of 723 participants with spinal cord injury who use a wheelchair for more than 40 hrs/wk treated at a Spinal Cord Injury Model Systems center was conducted.

Results: Significant increases were found in the number of participants reporting repairs (7.8%) and adverse consequences (23.5%) in a 6-mo period (2006–2011) compared with historical data (2004–2006) ($P < 0.001$). When examining current data, minorities experienced a greater frequency and higher number of reported consequences ($P = 0.03$). Power wheelchair users reported a higher number of repairs and consequences than did manual wheelchair users ($P < 0.001$). Wheelchairs equipped with seat functions were associated with a greater frequency of adverse consequences ($P = 0.01$). Repairs did not vary across funding source, but individuals with wheelchairs provided by Medicare and Medicaid reported a higher frequency of consequences than did the combined group of the Department of Vocational Rehabilitation, Worker's Compensation, and the Veterans Administration ($P = 0.034$ and $P = 0.013$, respectively).

Conclusions: The incidence and consequences of repairs are increasing from what was already a very high statistic in this United States population. Further investigation into causality is required, and intervention is needed to reverse this potential trend.

Key Words: Wheelchairs, Reference Standards, Equipment Failure, Spinal Cord Injury

More than 2.8 million Americans use a wheelchair for mobility.¹ This assistive technology provides users with the opportunity to achieve greater independence in physical functioning, mobility, home life, and vocational settings. Unfortunately, wheelchairs can pose a risk to users when failures occur. A 2009 study by McClure et al.² found that 44.8% of full-time wheelchair users experienced at least one repair in a 6-mo period. Wheelchair breakdown can cause adverse consequences ranging from minor inconveniences to decreased safety. In a study by Gaal et al.,³ 33% of adverse incidents and injuries were associated with wheelchair component failure. Another study by Xiang et al.⁴ reports 20% of adult injuries were caused by component failure. Wheelchair breakdown can result in a lack of mobility, which has been linked with reduced quality-of-life.^{5,6} Beyond mobility, wheelchair features such as power seating systems are integral for postural support, pressure management, and functional support.⁷ Breakdown of a wheelchair can also mean failure of these functions.

Efforts have been made by the International Standards Organization, the American National Standards Institute, and the Rehabilitation Engineering and Assistive Technology Society of North America to develop standards to decrease such incidents of injury and failure.⁸ However, current policy does not require wheelchair manufacturers to perform external testing of these standards for the wheelchairs they produce.⁹ Laboratory studies have found that many wheelchairs on the market do not meet the aforementioned standards.^{10–16} In the United States, vendors are reimbursed for wheelchairs according to a coding scheme that is independent of the cost and quality of the device. Furthermore, the Centers for Medicare and Medicaid Services have started competitive bidding in some areas which limits participating suppliers to those awarded contracts based on bids for reduced payment costs. Such practices may encourage cost-cutting and could result in a lower quality product.¹⁷ The goal of this study was to report the current incidence of wheelchair repairs, breakdowns, and consequences in a population of wheelchair users with spinal cord injury (SCI) and to compare current findings with historical data. A secondary goal was determine whether subject characteristics, occupation, income, level of education, funding source, type of wheelchair, and seating functions were related to the incidence of wheelchair breakdown and consequences.

METHODS

Participants were enrolled in the study if they were older than 16 yrs, had an SCI with discernible neurologic impairment that occurred at least 1 yr before the start of the study, were treated at a Spinal Cord Injury Model Systems (SCIMS) center, and used a wheelchair more than 40 hrs/wk. Subjects answered questions regarding their demographics, wheelchair, and occupation status. Subjects were asked to indicate the number of times in the past 6 mos the wheelchair they used most had been repaired. Those who reported repairs were asked to indicate which of the following five consequences occurred because of a wheelchair breakdown: (1) no consequence, (2) been stranded, (3) been injured, (4) missed work or school, or (5) missed a medical appointment. Data for this study were collected between June 2006 and February 2011 at the following six SCIMS centers: National Capital SCI Model System, Midwest Regional SCI Care System, Northeast Ohio Regional SCI System, Northern New Jersey SCI System, Regional SCI System of the Delaware Valley, and the University of Pittsburgh Model Center on SCI. Methods used to identify participants included approaching individuals who participated in the National SCI Database, through local registries, in response to posted flyers approved by the institutional review board, and identification by clinical staff. The current data set was also compared with a historical data set of 2213 full-time wheelchair users collected between April 2004 and March 2006.² Survey questions, inclusion criteria, and user identification methods were consistent across studies (current and historical). The data sets differ in the number of SCIMS centers included because the historical data set is from 16 SCIMS centers. All centers obtained institutional review board approval from their local institutional review boards before the implementation of study procedures and were responsible for recruitment and enrollment of participants at their center.

Data Reduction and Statistical Analysis

Data reduction and statistical analysis were completed in a manner similar to previously published work with the addition of the variables of funding source, income level, race, and seating functions.² The primary funding source that paid the most for the participant's wheelchair was examined and, to increase cell size, was recoded to a categorical variable: private/prepaid insurance, Medicare, Medicaid, and other. The "other" group was composed of funding sources represented by less

TABLE 1 Characteristics of full-time wheelchair users

Characteristics	Current Data (2006–2011)		Historical Data (2004–2006)	
	No. (%) of Subjects	No. of Missing Subjects	No. (%) of Subjects	No. of Missing Subjects
Sex		0		3
Male	1758 (79.4)		585 (80.9)	
Female	455 (20.6)		138 (19.1)	
Type of wheelchair used		0		0
Manual	1364 (61.6)		435 (59.9)	
Power	824 (37.2)		272 (37.5)	
Power assist	25 (1.1)		19 (2.6)	
Level of injury		31		20
Paraplegia	1061 (48.6)		325 (46.0)	
Tetraplegia	1121 (51.3)		381 (53.0)	
Occupational status		259		87
Working/student	687 (35.2)		353 (55.6)	
Unemployed/at home	1267 (64.9)		282 (44.4)	

than 10% of the participants and included Department of Vocational Rehabilitation, Worker's Compensation, Veterans Administration, and self-pay. To examine the effects of ethnicity, race was coded to a dichotomized variable of white and minority. Power wheelchair seat functions (tilt-in-space, recline, standing, seat elevation, and leg elevation) were analyzed individually and also dichotomized to two groups: seating functions and no seating functions. Variables were not normally distributed; thus, comparisons were made using either the Kruskal-Wallis test or the Mann-Whitney *U* test. Comparisons were made across individuals reporting/not reporting repairs and consequences. χ^2 Analysis was completed to determine whether type of chair and seat functions were associated with a greater number of repairs or adverse consequences. This set of data was also compared with historical data reported by our group using paired comparisons. All statistical analyses were completed using SPSS version 14.0. The level of significance was set a priori at $\alpha = 0.05$. To correct for multiple comparisons, the Holm test was used, which orders unadjusted *P* values and then accepts or rejects the

tests with decreasing rigidity, based on the number of tests already done.

RESULTS

Subject Characteristics

A total of 726 full-time wheelchair users participated in this study. Participants were, on average, 42.9 ± 13.8 yrs of age and 12.5 ± 11.0 yrs post injury. Demographic information on this group can be found in Table 1. There were no significant differences in the number of repairs or adverse consequences experienced based on age, years since injury, sex, occupational status, and level of education. No significant differences in subject characteristics existed between this data set and the historical data set.

Increase in Repairs and Consequences

As can be seen in Table 2, there was a significant increase in the number of repairs and consequences compared with historical data ($P < 0.001$). Of those who could recall the exact number of repairs completed in the last 6 mos, 45.8% reported

TABLE 2 Historical comparison of repairs and consequences

	Current Data (2006–2011)	Historical Data (2004–2006)	<i>P</i>
Repairs			
≥ 1 Repairs	52.6%	44.8%	<0.001
No. of repairs/person, mean \pm SD	1.43 \pm 3.56	1.03 \pm 2.68	<0.001
Consequences			
≥ 1 Consequences	30.5%	22.1%	<0.001
No. of consequences/person, mean \pm SD	0.47 \pm 0.81	0.30 \pm 0.65	<0.001

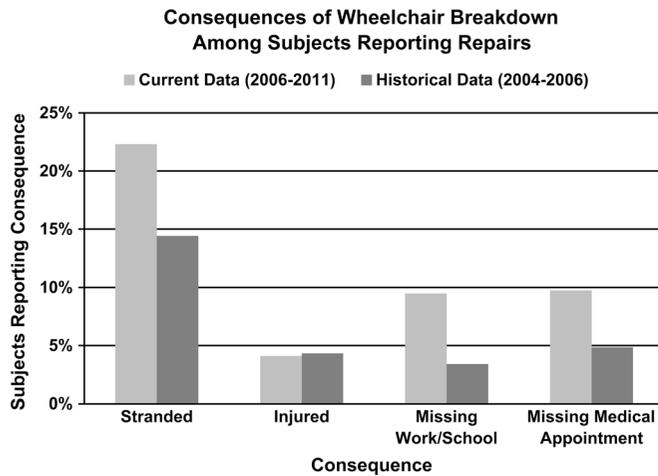


FIGURE 1 Historical comparison of consequences from wheelchair breakdown.

one repair, 36.9% reported two to three repairs, and 17.3% reported four or more repairs. A total of 6.7% reported repairs but could not remember the exact number completed.

A total of 178 adverse consequences resulting from wheelchair breakdown were reported. A significantly higher number of consequences per person were reported as compared with historical data ($P < 0.001$). In addition, significantly more participants reported each consequence ($P < 0.001$) as compared with historical data (Fig. 1).

Wheelchair Factors

Similar to historical data, significant differences were found in repairs and consequences experienced based on type of wheelchair. A higher number of power wheelchair users reported requiring repairs as compared with historical data ($P < 0.001$). Of those who reported repairs, a higher number of power wheelchair users reported experiencing consequences ($P < 0.001$), being stranded ($P < 0.001$), and missing a medical appointment ($P < 0.001$) as compared with manual wheelchair users. Of those reporting consequences, 64.6% were power wheelchair users. A higher number of repairs ($P < 0.001$) and consequences ($P < 0.001$) were reported by power wheelchair users. There were no differences in the percentage of manual and power wheelchair users as compared with historical data.

Wheelchairs equipped with seat functions were not reported to require more repairs ($P = 0.156$); however, there were more and a higher number of adverse consequences ($P = 0.011$ and 0.008 , respectively). Specifically, a greater number of individuals reported being stranded ($P = 0.046$), being injured ($P = 0.004$), and missing a medical appointment ($P = 0.024$). Of those reporting repairs, 29.6% had tilt-in-space, 19.9% had recline, 1.8%

had standing, 11.0% had seat elevation, and 12.6% had elevating leg rests.

Funding Source

As seen in Table 3, funding source differed from historical data ($P < 0.001$). Whereas there were no differences in repairs across these groups, a significantly higher number of consequences were reported for Medicare ($P = 0.034$) and Medicaid ($P = 0.013$) as compared with the category of “other.” The distribution by funding source of those reporting one or more consequences is as follows: 20.0% private/prepaid, 36.8% Medicare, 36.6% Medicaid, and 20.9% other. Compared with historical data, where 62.8% of participants reported having a backup working wheelchair, significantly fewer people (34.4%) reported to have a working backup wheelchair for this study ($P < 0.001$). Significantly fewer individuals reported having a working backup wheelchair when funded by Medicaid (25.4%) as compared with Medicare ($P < 0.001$). There were significant differences in income brackets reported based on funding source. Those with private/prepaid insurance had significantly higher incomes than did those with all other funding sources ($P < 0.001$ to $P = 0.001$). Those with other as their funding source

Funding Source	Current Data (2006–2011)	Historical Data (2004–2006)	<i>P</i>
Private/prepaid insurance	28.9%	37.5%	<0.001
Medicare	16.2%	17.9%	0.331
Medicaid	30.6%	21.0%	<0.001
Other ^a	24.1%	23.7%	0.797

^aIncludes Department of Vocational Rehabilitation, Worker's Compensation, Veterans Administration, and self-pay.

reported significantly higher income than did both those funded by Medicare and those funded by Medicaid ($P < 0.001$).

Race

Whites were less likely than minorities to experience consequences ($P = 0.031$) and experienced a lower number of total consequences ($P = 0.028$). Whites were more likely to have a backup wheelchair ($P < 0.001$). There was an increase in the percentage of minority participants as compared with historical data (23.3%–39.6%; $P < 0.001$). Differences were found between whites and minorities in the type of funding and combined annual household income ($P < 0.001$). Specifically, there were more minorities in the income brackets of less than \$10,000 ($P < 0.0001$) and \$10,000–\$14,999 ($P = 0.008$) and more whites in the income brackets of \$35,000–\$49,999 ($P = 0.004$) and \$75,000 or greater ($P < 0.001$). More minorities reported Medicaid as their funding source (53.3% vs. 14.8%; $P < 0.001$), and significantly fewer minorities reported private/prepaid insurance (14.9% vs. 40.5%; $P < 0.001$) or other (16.5% vs. 28.2%; $P = 0.001$) as compared with whites. Minorities were less likely to have a seat elevator ($P = 0.012$) and elevating legs ($P = 0.038$).

DISCUSSION

This study indicates that there has been a significant increase in the number of individuals requiring at least one wheelchair repair in a 6-mo period. When repairs were required, significantly more participants experienced four or more repairs. In addition, a greater number of participants experienced adverse consequences because of breakdown. The total number of consequences divided by the number of participants more than doubles that of historical data. It is possible that this increase in the number of repairs is the result of a decrease in wheelchair quality resulting from changes in reimbursement policies and lack of enforcement of standards testing.

Manual and Power Wheelchair Differences

Power wheelchairs were more likely to require repairs and to result in consequences as compared with manual wheelchairs, with 65% of all consequences reported by power wheelchair users. It is possible that cost-cutting practices by manufacturers are resulting in a decreased product quality. Because there was no difference in the number of repairs reported across funding sources, it is possible that

there is an overall decrease in quality. This could be impacting seating function reliability. In addition, individuals with power wheelchairs equipped with seating functions report a higher percentage of consequences and a higher number of consequences per person and incidents of being stranded, injured, and missing a medical appointment as compared with historical data. These data suggest that seating system reliability may be called into question as the number of required repairs increased as the number of seating functions increased. The consequences of breakdown of a power wheelchair with seating functions stretch beyond not being able to move independently from point A to point B. A lack of access to seating functions can result in development of pressure ulcers, pain, and dependence on others. Because of impairment and the complexity of the system, power wheelchair users are less likely to be able to fix a wheelchair independently. This is one possible explanation of the higher rate of consequences. Furthermore, it has been noted that a technician cannot repair certain components and it is necessary to return the wheelchair to the manufacturer for repair, costing time, money, and independence.¹⁴ If an individual does not have a backup wheelchair, he/she may be forced to remain immobile and often in bed for extended periods of time. Importantly, this study found that the percentage of individuals with backup wheelchairs dropped by approximately 50% as compared with historical data.

Funding

Individuals with Medicare and Medicaid as their primary funding sources reported a significantly higher number of consequences than did a combined group of individuals funded through the Department of Vocational Rehabilitation, Worker's Compensation, and the Veterans Administration. This increased incidence of consequences may be tied to a lack of means to accommodate a breakdown. Individuals with Medicare or Medicaid are likely to be from lower income brackets. Individuals with Medicaid were less likely to have a working backup wheelchair, indicating that a breakdown may leave them stranded. The effects of breakdown are likely exacerbated among these groups because an adequate support system and economic resources may not be available.

Several aspects of the Centers for Medicare and Medicaid Services policy may be factors in the incidence of breakdowns. The Centers for Medicare and Medicaid Services use Healthcare Common Procedure Coding System to identify durable medical equipment in a consistent fashion for billing

purposes and in formulating fee schedules. However, these fee schedules are set independent of quality or performance, and there are no current requirements for external American National Standards Institute/Rehabilitation Engineering and Assistive Technology Society of North America testing to ensure quality across chairs within a category or group. In addition, the introduction of the new competitive bidding process in some areas forces suppliers to reduce payment levels. With a fixed fee schedule and competitive bidding, dealers may push lower quality wheelchairs and services provided may be sacrificed to maintain profit margins.¹⁷

Economic Impact

Compared with able-bodied counterparts, wheelchair users face much higher unemployment rates. In 1997, the reported unemployment rate of wheelchair users on the Survey of Income and Program Participation was 77.8%.¹⁸ Thirty-one percent of individuals in this study reported missing work or school because of wheelchair breakdown. In a population already at a disadvantage in the realm of employment, wheelchair failures can make it more difficult to maintain a job or pursue higher education. In addition, injuries that result from wheelchair breakdown, as reported by 32.0% of participants, can further prevent wheelchair users from working because of added secondary complications (broken bones, cutaneous wounds, etc.) that may arise. An additional barrier to employment is a lack of backup wheelchair.

Race

Minorities were more likely to experience a consequence and a higher number of consequences per person. In addition, fewer minorities reported having a seat elevator and elevating leg rests as compared with whites. This disparity in performance and provision of assistive technology is consistent with previous studies, which concluded that there remain groups of individuals with disabilities not adequately supported by programs with financing for assistive technology.^{19,20} Supported by Clinical Practice Guidelines from the Consortium for Spinal Cord Medicine, a seat elevator is often an integral part of activities of daily living.²¹ It is the policy of the Centers for Medicare and Medicaid Services that seat elevators are considered a luxury item and will not be funded.

Standards Testing

The Rehabilitation Engineering and Assistive Technology Society of North America Standards

Committee on Wheelchairs has developed extensive standards for wheelchair testing. These tests are designed to mimic 5 yrs of use and objectively evaluate the safety and performance of wheelchairs. At present, the Food and Drug Administration does not require these tests; it merely recommends that chairs pass American National Standards Institute/Rehabilitation Engineering and Assistive Technology Society of North America standards. In cases where manufacturers do carry out testing, they are not required to use an external facility. It has been shown that many chairs on the market do not meet standards when external testing is performed.¹⁰⁻¹⁶ With the high incidence of required repairs and consequences resulting from wheelchair breakdown, it is imperative that this and other funding regulations be reexamined.

Study Limitations

There are several limitations to consider with this study. In this study, we draw comparisons with a historical data set. Although consistent survey questions, inclusion criteria, and user identification methods were used, there was a change in the SCIMS centers involved in the current data set. Because the studies provide only two data points, caution must be used when interpreting a trend. However, both studies contain relatively large samples, lending further credence for concern. In addition, although we asked about the number of repairs and the type of consequence, we did not ask participants about the number of consequences reported. For example, an individual may have experienced a consequence every time his/her wheelchair was repaired; however, it was only noted that this consequence occurred. As such, we may have underrepresented the number of consequences experienced. The preceding study, which was reported in 2009, may have raised awareness on issues of repair, breakdown, economic impact, and standards testing. In addition, individuals may be increasing their activity and thus increasing the use of their chairs. Furthermore, all subjects were recruited from Model Spinal Cord Injury Systems facilities, which are centers of excellence, so we may be underestimating the number of repairs and consequences as compared with the general population.

CONCLUSIONS

This study found a significant increase in the number of repairs and consequences, with 52.6% of full-time wheelchair users experiencing at least one wheelchair repair in the past 6 mos and 32.2% of

those individuals experiencing at least one consequence because of wheelchair breakdown. Minorities experienced a greater frequency of breakdown and higher number of reported consequences. A greater number of repairs were associated with power wheelchairs and specifically with those equipped with seat functions. The increase in required repairs and consequences may be associated with a decrease in wheelchair quality because of changes in insurance reimbursement policy and lack of standards enforcement. Future investigation into the cause of the increases in reported repairs and consequences is needed. Future studies need to look at the manufacturer and model of wheelchairs to see whether differences can be identified which allow for targeted prescription of higher quality wheelchairs. Furthermore, future studies also need to educate wheelchair users on maintenance. It is possible that education on routine maintenance such as replacing cushions, caster wheels, and batteries at given time points can help prevent wheelchair breakdown and resulting adverse consequences. Finally, this article should serve as a call to reevaluate and revise current policies and standards testing for wheelchair prescription in the United States.

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