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Risk of hospitalizations after spinal cord injury: Relationship with biographic, injury, educational, and behavioral factors

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Abstract

Objectives—To assess the risk factors associated with hospitalization and the relationship of individual health behaviors with hospitalizations following spinal cord injury (SCI).

Study Design—Cross-sectional survey.

Setting—A large specialty hospital in the Southeastern USA.

Methods—Persons with SCI responded (n=1386) to a mail survey assessing various aspects of their health including health behaviors and number of hospitalizations in the past year. Logistic regression was used to assess the relationships between biographic, injury, educational, and health behavior factors with hospitalization in the past year.

Results—Overall, 36.6% of participants were hospitalized on at least one occasion during the previous year. Two biographic and injury characteristics were associated with hospitalization: race and SCI severity. Specifically, minorities and persons with non-motor functional high cervical or non-cervical SCI (ASIA grades A–C) were more likely to be hospitalized. Three behavioral factors were significantly associated with hospitalization after controlling for biographic and injury characteristics. Persons who used prescription medications, those who engaged more in smoking behaviors, and persons who reported more SCI specific health behaviors were more likely to be hospitalized.

Conclusion—Specific health behaviors are associated with increased hospitalization among persons with SCI. Future research is needed to assessing the time-sequence of these relationships.

Keywords

Spinal cord injury; Health behaviors; Hospitalization; Prescription medication; Smoking

Introduction

Traumatic spinal cord injury (SCI) occurs unexpectedly and generally results in permanent sensory and motor loss. The long term costs, both personal and economic, are staggering.

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Direct medical costs are estimated between $228,566–$775,567 during the first year after injury, and $16,018–$138,923 for each subsequent year.1

One of the primary consequences after SCI related to medical costs is hospitalization for medical complications. A Canadian study found that in the first year post-injury, costs due to hospitalizations ranged from $600–$6300, and, in the subsequent five years, ranged from $3,500–$15,800 per person.2 Therefore, hospitalizations account for a large amount of direct costs after SCI. However, the personal cost of hospitalizations cannot be overestimated, as hospitalizations are a primary risk factor for early mortality.3

In the first year post-injury, between 26.0% and 39.0% of persons are re-admitted to the hospital.4–6 Rates of hospitalization have ranged from 0.55 to 1.85 hospitalizations per person per year in the first year post-injury, 7 and 0.26 to 0.55 in subsequent years.8–10 The average length of stay for hospitalizations ranges from 4.0 to 11.9 days.6, 11 The most common organ systems involved with complications for hospitalization are genitourinary, skin, respiratory, and digestive.7, 12

While the studies above have characterized the rates of hospitalization post-SCI, only a few have examined risk factors associated with hospitalization. The highest rates of hospitalization are reported among persons with motor-complete SCI and those who depend on mechanical ventilation.5 Having an indwelling catheter and no bladder autonomy were associated with hospitalization.5, 9 Also related to injury severity, having lower Functional Independence Measure (FIM) score and a lower Craig Handicap Assessment and Reporting Technique (CHART) physical independence score at discharge were associated with increased hospitalization.7, 10 Persons with lower socioeconomic status (SES), including lower education and persons with government insurance were also more likely to be hospitalized.7 as were males,9 and African-Americans.13 While these studies help to identify specific biographic and injury characteristics associated with hospitalization, most of these factors, with the exception of SES, are not modifiable. There has been no research focusing on the association of hospitalization and modifiable risk factors, such as health behaviors, which have previously been associated with mortality after SCI.14

Summary and Purpose

Previous studies have helped to define the frequency and cost of hospitalizations, as well as contributing to our understanding of the relationships between injury and biographic characteristics with hospitalization. However, there is still a need to identify underlying modifiable factors which increase the risk of post-injury hospitalization, as it is the knowledge of these factors which can facilitate the development of intervention strategies. Because hospitalizations represent a primary indicator of health outcomes15 and are related to the development of secondary heath conditions, it is important to understand the association of the individuals' behavior and the probability of hospitalization.

Our purpose was to identify risk factors for hospitalization using a broad range of biographic, injury, educational, and behavioral predictors. Our objectives were to identify: (a) the annual incidence of hospitalizations, (b) risk factors associated with hospitalization, and (c) the relationship of individual behaviors with hospitalizations.

Materials and Methods

Participants

Participants were selected from outpatient records of a large Southeastern specialty hospital in the USA that has been designated by the US National Institute of Disability and Rehabilitation Research as a SCI Model System. Participants were selected from multiple sources that included inpatient and outpatient records. There were three inclusion criteria: (1) traumatic SCI, (2) 18 years of age or older, and (3) at least one year post-injury. A total of 1386 returned completed surveys (a 72% response rate).

Procedures

The study was introduced to participants by cover letter. Approximately 4–6 weeks later the first set of materials was mailed. A second set of materials was sent to all non-respondents, followed by a phone call. A third mailing was initiated to those who requested additional materials. Participants were offered $20 remuneration for completing the study materials and were made eligible for drawings totaling $1,500. We contacted participants by phone or by mail to obtain missing information if it appeared that skipping items was unintentional such as when it appeared that pages stuck together and were missed completely. No attempts were made to complete sporadic or selective missing items.

Statement of Ethics

We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

Measures

A survey that was a composite of several instruments was utilized. We utilized the following biographic, injury, and educational variables: gender, race (dichotomized into Caucasian and minority), current age, years since injury onset, injury severity, years of education, and income. Behavioral measures were comprised of seven latent factor scales identified during previous research16 through factor analysis of several behavior item sets. These included alcohol and tobacco usage, psychotropic prescription medication use, nutrition, wellness variables, and SCI specific secondary condition prevention behaviors. The seven behavioral domains included: smoking, alcohol misuse, psychotropic prescription medication use, healthy nutrition, unhealthy nutrition, fitness, and SCI specific health behaviors.

The Behavioral Risk Factor Surveillance System (BRFSS)17 is a standardized instrument that is used by the Centers for Disease Control and Prevention to monitor relevant basic health behaviors within the general population. We used two alcohol items, number of days consuming alcohol in the last month and the number of occasions in the past month consuming five or more drinks (i.e., binge drinking), and three tobacco items (ever been a regular smoker, number of cigarettes currently smoke per day, and do you smoke in the bed*). The nutritional items in the BRFSS were supplemented with items that tap risk elements not incorporated in the BRFSS based on the recommendations of a CDC fitness

*This item was actually added from the Health Survey.

specialist. There were 11 items: drink juice, eat fruit, eat salad, eat carrots, eat vegetables, eat breakfast, eat potatoes, eat fried foods, eat red meat, eat junk food, and add salt to food. Participants were asked to report frequency using a five point scale: (a) never, (b) less than once a month, (c) less than once a week but at least once a month, (d) at least once a week but not every day, and (e) once a day or more.

Participants also completed the CAGE,18 a highly accurate, four-question screening tool designed by primary care physicians for detecting alcoholism in the general population. It was used as a proxy measure for alcohol misuse behaviors.

The Spinal Cord Injury Health Survey19 was developed for the study to measure other content domains including psychotropic prescription medication use, healthy life style, and SCI specific health behaviors (these are described more fully in Krause et al.16). Participants were asked how frequently they used medications for pain, spasticity, depression, and sleep. Usage of prescription medications was found to be predictive of subsequent injuries19 and pressure ulcers.20 Four items measured exercise and healthy lifestyle. One final set of items asked participants how frequently they do certain behaviors in an effort to maintain their health. These items included: perform skin checks, do weight shifts, drink extra water, turn in bed, or check urine. Participants were presented four response choices for each item depending on how frequently they did the activity.

Race was dichotomized as Caucasian and all others (Minority). Injury severity was categorized into four groups based on a combination of ambulatory status and level of injury. Persons who were non-ambulatory were categorized as C1–C4 (high cervical), C5–C8 (low cervical), or T1-S5 (non-cervical). All persons who were ambulatory were grouped together. Education was categorized into the following four groups: (a) <12 years (< High School), (b) 12 years (High School), (c) 13–15 years (Some College), and (d) 16+ years (College +). Income was categorized into four groups: (a) less than $15,000, (b) $15,000–$24,999, (c) $25,000–$49,999, and (d) $50,000 or more.

Our primary outcome was hospitalization in the past year. This question asked how many times the individual had been hospitalized in the past year for any reason. For this study, we dichotomized hospitalization in the past year as yes (1+ hospitalization) or no (0 hospitalizations). No attempt was made to verify hospitalization (e.g., through obtaining hospital records).

Analyses

We used the Chi-Square statistic to evaluate the statistical significance of bivariate relationships between hospitalization and race, gender, education, and income, and a t-test for the relationships between hospitalization and age and years since injury. Results from these analyses were used in model building, variables with a p-value <.25 were considered in the full model.

Factor scores for seven behavioral domains were calculated using the results from the confirmatory factor analysis by Krause et al.16 Estimated factor scores are a linear combination of the variables making up that particular domain. The seven domains included

in our analysis were: (a) smoking, (b) alcohol misuse, (c) psychotropic prescription medication use, (d) healthy nutrition, (e) unhealthy nutrition, (f) fitness, and (g) SCI specific health behaviors. Since these domains were our primary independent variables of interest, they were included in the full model regardless of significant bivariate association.

For the model building, we used multivariable logistic regression with our outcome being hospitalization (yes vs. no). We used Chi-Square analyses to assess the relationships between the predictor variables and hospitalization. Variables with a significant univariate relationship with the outcome ($p<.25$) were considered for the full model. Hosmer-Lemeshow and global chi-square tests were used to assess goodness-of-fit of the model.21 The C-statistic, measuring area under the Receiver Operating Characteristic curve, was used to assess discriminatory ability.21 Odds ratios with 95% confidence intervals (CIs) are reported.

Results

Participant Characteristics

Seventy-four percent of the sample was male, and 74.8% were Caucasian, with another 22.2% African-American. Cervical injuries were reported by 54.6% of the participants. The primary etiology was motor vehicle crashes (50.7%), followed by falls-flying objects (17.4%), acts of violence (12.8%), and sporting events (12.0%). Just over 21.3% retained some ability to walk. The participants were an average of 31.7 years of age at the time of injury and 41.5 years of age at the time of the study (an average of just less than 10 years had passed since SCI onset). The average number of years of education was 13.1 years.

Descriptive

Overall, 36.6% of participants were hospitalized on at least one occasion during the previous year. Among those who reported at least one hospitalization, the average number of hospitalizations was 2.0. The average number of days hospitalized during the previous years was 12.0 for those with at least one hospitalization. The average length of stay per hospitalization was 7.0 days. Table 1 shows the breakdown of the average length of stay per hospitalization by key biographic and injury characteristics. While differences were seen between the biographic and injury characteristics, those with the shortest average length of stay were persons of a higher socioeconomic status. Persons with a college level or higher education and those whose income was $50,000 per year or more had the shortest average length of stay. Persons hospitalized were more likely to be minority, have higher injury severity, less education, lower income, and younger in age (Table 2).

Predictive

The final model (Table 3), had good fit as suggested by the Hosmer-Lemeshow goodness of fit test ($X^2=2.66$, 8 DF, $p=0.95$). The C-statistic was 0.69, which almost meets the criteria (0.70) for acceptable discrimination of the model. While education, income, and age were significant in the bivariate relationships, they did not retain significance in the multivariable model. Only two of the biographic and injury characteristics were significant in the final model. Minorities were 1.61 times more likely to be hospitalized than Caucasians (OR=1.61,

95% CI: 1.23–2.12; p=0.0007). In addition, persons with a non-functional high cervical or non-cervical SCI were more likely to be hospitalized than persons with an ASIA D injury.

Three of the behavioral factors were significantly associated with hospitalization. Prescription medication use was the strongest behavioral factor associated with hospitalization, where persons who used prescription medications (higher prescription medication factor score) more often were more likely to be hospitalized. Also, persons engaging in smoking behaviors (higher smoking factor score) were more likely to be hospitalized. Lastly, persons who were more likely to report SCI specific health behaviors were more likely to be hospitalized.

Discussion

The results of this study both support and extend previous research on hospitalizations after SCI. The findings clearly suggest that hospitalizations occur frequently and are debilitating in terms of the number of days hospitalized. The unique contribution of this study was in the analysis of behavioral correlates of hospitalizations.

The univariate analyses indicate that multiple variables were significantly associated with hospitalizations, including race-ethnicity, injury severity, education, income, and age. The lowest risk of hospitalization was for highly educated, older Caucasians with high income and less severe injuries. In contrast, the multivariate modeling identified the optimal predictors of hospitalization, essentially controlling for biographic and injury characteristics, while identifying the association of the behavioral dimensions with hospitalizations.

The pattern of significant findings is enlightening. Three of the four significant behavioral dimensions were retained in the final model (all except fitness), including psychotropic prescription medication use, smoking, and SCI specific health behaviors. The fact that SCI specific health behaviors were a risk factor for hospitalizations underscores the correlational nature of the data. Just as we almost certainly would not assume that these behaviors led to a greater risk of hospitalization, we cannot assume that prescription medication use is a cause of hospitalization. The most likely explanation of the relationship between SCI specific health behaviors and hospitalizations is that the development of health problems likely leads individuals to perform more health related behaviors by necessity. However, the findings that psychotropic prescription medication use and smoking are risk factors for hospitalization must also be interpreted with caution and, at least with prescription medication use, the relationship may be one of mutual influence or with both medication use and hospitalizations being precipitated by another factor (e.g. health decline). It is interesting that smoking was related to hospitalizations, yet alcohol misuse was not. Self-reported alcohol misuse has been associated with subsequent injury that frequently results in hospitalizations,19 so it is surprising that it is not associated with risk of hospitalizations in this study.

Limitations

There are several limitations. First, all data are self-report and therefore susceptible to recall bias. We utilized a one year follow-up interval to minimize the likelihood of recall bias

influencing the study results. Second, the data are cross-sectional rather than longitudinal. Therefore, we cannot determine how the probability of hospitalizations changes over time. A third similar limitation is that, due to the cross-sectional nature of the study, we do not know the time sequence of events between the behavioral predictors and hospitalizations. This clearly is problematic with the relationship between SCI specific health behaviors and elevated risk for hospitalizations. Lastly, the study is restricted to behaviors. It would also be helpful to investigate the relationships of other types of risk factors to hospitalizations.

Future Research

The needs for further research parallel the limitations. Specifically, further research is needed to identify longitudinal changes in hospitalizations. Designs that use cross-lagged correlations would help to identify which parameters are influencing each other. An additional focus on health predictors of hospitalizations would be particularly helpful. Such research should include a focus on multiple secondary health conditions, particularly those that are known to be associated with an elevated risk of hospitalization (e.g. pressure ulcers). The ultimate goal of any research that identifies risks and protective factors of an adverse outcome is the translation of this research into practice. Therefore, perhaps the most important area for further research is prevention of readmissions. It is only through further research that we will gain a more comprehensive understanding of risk of hospitalizations and more effectively develop prevention strategies to minimize this risk.

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Table 1

The mean number of days hospitalized per hospitalization among persons who were hospitalized at least once in the past year (n=497).

Variable	Mean Number of Days (S.D.)
Race	
Caucasian	6.9 (7.1)
Minority	7.3 (7.2)
Gender	
Male	7.1 (7.1)
Female	6.7 (7.1)
Injury Severity	
C1–C4, ABC	6.3 (6.0)
C5–C8, ABC	7.0 (7.2)
Non Cervical, ABC	7.5 (7.4)
ASIA D	6.5 (7.5)
Education	
< High School	7.8 (7.5)
High School	6.7 (6.5)
Some College	7.7 (8.2)
College +	5.6 (6.2)
Income per year	
< $15K	7.1 (6.9)
$15–$25K	7.9 (8.1)
$25–$50K	6.6 (6.6)
$50K +	5.8 (6.8)

Table 2

Biographic and injury characteristics of persons with SCI by hospitalization status.

	Total N	Hospitalization			
Variable	**(n=1359)**	**Yes (n=497)**	**No (n=862)**	**Total %**	**p-value**
Race			*Column Percent*		
Caucasian	1017	69.8	77.7	74.8	
Minority	342	30.2	22.3	25.2	0.0012
Gender					
Male	1005	73	74.5	74	
Female	354	27	25.5	26.1	0.56
Injury Severity					
C1–C4, ABC	185	17.1	11.6	13.6	
C5–C8, ABC	411	30	30.4	30.2	
Non Cervical, ABC	473	37.6	33.2	34.8	
ASIA D	290	15.3	24.8	21.3	<.0001
Education					
< High School	262	25.8	15.8	19.4	
High School	419	33.1	29.9	31.1	
Some College	355	22.9	28.3	26.3	
College +	312	18.3	26	23.2	<.0001
Income per year					
< $15K	547	50	37.2	41.8	
$15–$25K	228	17.9	17.2	17.4	
$25–$50K	294	17.3	25.4	22.5	
$50K +	329	14.8	20.3	18.3	<.0001
Age [mean(s.d)]	1356	40.9(13.3)	42.6(14.3)	41.5(13.7)	0.0288
Years Since Injury [mean(s.d)]	1347	9.8(6.6)	9.5(7.4)	9.7(6.9)	0.4374

Table 3

Results from the multivariable logistic regression model of hospitalization

	Bivariate Relationships		Multiple Logistic Regression	
Variables	**Crude OR (95% CI)**	**p-value**	**Adjusted OR[1] (95% CI)**	**p-value**
Race (vs. Caucasian)				
Minority	1.51(1.18–1.94)	0.0013	1.61(1.23–2.12)	0.0007
Gender (vs. Male)				
Female	1.08 (0.84–1.38)	0.56	N/A	N/A
Injury Severity (vs. ASIA D)				
C1–C4, ABC	2.39 (1.62–3.53)		1.77 (1.14–2.75)	
C5–C8, ABC	1.60 (1.15–2.23)		1.37 (0.94–1.98)	
Non cervical, ABC	1.84 (1.34–2.54)	0.0001	1.74 (1.22–2.48)	0.011
Education (vs. College +)				
Some College	1.15 (0.83–1.60)		N/A	
High School	1.57 (1.15–2.15)		N/A	
11 Years or less	2.32 (1.64–3.28)	<.0001	N/A	N/A
Income (vs. $50K+)				
$25–50K	0.93 (0.64–1.36)		N/A	
$15–25K	1.44 (0.98–2.114)		N/A	
Less than $15K	1.85 (1.33–2.56)	<.0001	N/A	N/A
Age	1.009 (1.001–1.017)	0.026	N/A	N/A
Years Since Injury	0.99 (0.98–1.01)	0.42	N/A	N/A
Factors				
Prescription Meds	2.58 (2.12–3.14)	<.0001	2.43 (1.92–3.08)	<.0001
Alcohol Use	1.00 (0.98–1.03)	0.95	1.01 (0.98–1.05)	0.35
Positive Nutrition	0.86 (0.72–1.03)	0.098	0.87 (0.69–1.10)	0.25
Negative Nutrition	0.88 (0.74–1.05)	0.15	0.88 (0.72–1.08)	0.22
Smoking	1.43 (1.20–1.71)	<.0001	1.27 (1.02–1.58)	0.035
Fitness	0.61 (0.50–0.75)	<.0001	0.93 (0.71–1.20)	0.56
SCI Specific Behaviors	1.90 (1.46–2.48)	<.0001	1.43(1.00–2.03)	0.047

[1] Adjusted for all other variables in the model.