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ORIGINAL ARTICLE

Suicide Mortality After Spinal Cord Injury in the United States: Injury Cohorts Analysis

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Abstract

Objectives: To compare 12-year suicide-specific mortalities of 3 different injury cohorts, identify the risk factors for suicide mortality after spinal cord injury (SCI), and investigate whether suicide mortality is higher among those with SCI than in the general population.

Design: Retrospective cohort study.

Setting: United States hospitals (n=28) designated as SCI Model Systems.

Participants: Participants (N=31,339) injured between January 1, 1973, and December 31, 1999.

Interventions: Not applicable.

Main Outcome Measure: Suicide death after SCI.

Results: The crude annual suicide mortality rate during the first 12 years after SCI was 91 per 100,000 person-years for 1973 to 1979 injury cohort, 69 per 100,000 person-years for 1980 to 1989 injury cohort, and 46 per 100,000 person-years for 1990 to 1999 injury cohort. Suicide mortality was associated with race, injury severity, and years since injury. The standardized mortality ratios for the 3 cohorts were 5.2, 3.7, and 3.0, respectively.

Conclusions: Suicide mortality among those with SCI decreased over 3 injury cohorts, but it still remained 3 times higher than that of the general population.

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Suicide is a salient problem among people with spinal cord injury (SCI). As suicide has been associated with sudden and depressed life events, persons with SCI may have a higher suicide rate than the general population.[1] Previous studies provide empirical support for this hypothesis. In comparison to the United States (U.S.) general population, those with SCI in the U.S. have a suicide rate 2 to 6 times higher.[2-5] One study[6] conducted in Denmark found the suicide rate of persons with SCI was about 5 times greater than that of the general population. An Australian study[7] reported the estimated suicide rate among persons with SCI was 4.4 times greater than that among the general population. Another Norwegian study[8] remarkably reported a suicide rate that was 37.6 times greater among women with SCI and 3.7 times greater among men with SCI. Studies also show that 50% of people with SCI have had suicidal thoughts,[9] and 10% to 15% report having suicidal plans during the first 6 months after their injury.[10]

Except for a few studies,[2,6,11,12] our knowledge regarding suicide after SCI is still limited. Meanwhile, no studies have investigated cohort differences in suicide mortality after SCI. In the general population, suicide rates increased during the early 1990s, but a decline occurred thereafter.[13] The overall U.S. suicide rate decreased 11.1% (from 12.4 per 100,000 to 11.0 per 100,000) between 1990 and 2005. During the same time, we saw the passage of the Americans with Disabilities Act in 1990 aimed at prohibiting discrimination based on disability, and social movements advocating for legislative rights of better living conditions, social changes of equal opportunity, and independent living for

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people with disability throughout the U.S. This raises the question of whether suicide rates among the SCI population have changed over different injury cohorts.

To bridge the gap in the literature, we compared 12-year suicide-specific mortalities of 3 different injury cohorts and identified the risk factors for suicide mortality using the largest SCI database in the world. In addition, we addressed whether suicide deaths were higher after SCI than in the general population and whether the observed suicide mortality differences between the SCI population and the general population were noted across injury cohorts.

Methods

Data sources

This study retrieved data from the National Spinal Cord Injury Statistical Center (NSCISC) database, which contains data reported from 28 U.S. hospitals designated as SCI Model Systems (SCIMS) of care since 1973. NSCISC Database Institutional Review Board approval was obtained locally at each hospital before data collection. This database has the largest SCI sample in the world and captures an estimated 13% of new SCI cases every year in the U.S.[14,15]

Measures

Our outcome variable was a dichotomous event, suicide death or not. First, we identified the deceased cases by routine follow-up with personnel at each SCIMS center and supplemented this with searches of the National Death Index and Social Security Death Index. Second, the cause of death was determined from death certificates, autopsy reports, hospital discharge summaries, or the *International Classification of Diseases* codes provided by a National Death Index search. The mortality information was recently updated at the end of 2011. Based on their year of injury, we divided all participants into 3 cohorts: injured between 1973 and 1979, injured between 1980 and 1989, and injured between 1990 and 1999. Because suicide mortality varies with years postinjury,[2] we gave each cohort exactly 12 years of follow-up to achieve comparable suicide rates.

The following independent variables were measured at the time of injury: sex (female vs male), race (non-Hispanic white, non-Hispanic black, Hispanic, others), education (college education vs others), age, injury etiology, and injury severity. Injury etiology was grouped into motor vehicle collisions, violence, sports, fall, and all others. Injury severity information was collected at discharge from the initial hospital care. It was classified as follows: C1-4 level with American Spinal Injury Association Impairment Scale (AIS) A, B, or C injuries; C5-8 level with AIS A, B, or C injuries; T1-S3 level with AIS A, B, or C injuries; and all levels with AIS D injuries (functional motor recovery). All ventilator-dependent cases were included in the first group. This is the typical scheme used in previous SCIMS research.[16-18] For injury severity information, because 2305 participants are unknown, we added a new category "unknown" to the injury severity variable. We also found missing values for race and education, and we categorized them into "others" in the analysis. The year since injury was a time-variant predictor, increasing by 1 for each additional person-year. In our logistic regression analysis, we treated it as a 6-category variable (1−2y, 3−4y, 5−6y, 7−8y, 9−10y, >10y).

List of abbreviations:

AIS	**American Spinal Injury Association Impairment Scale**
NSCISC	**National Spinal Cord Injury Statistical Center**
SCI	**spinal cord injury**
SCIMS	**Spinal Cord Injury Model Systems**
SMR	**standardized mortality ratio**
U.S.	**United States**

Analysis

We first estimated the crude annual suicide-specific mortality rate based on the person-year denominator for each of the 3 injury cohorts. Multivariate analysis was conducted using a logistic regression model on person-year observations.[19-21] Every participant was followed up beginning with the date of injury up to 12 years. If participants were still alive after the 12-year follow-up, they were regarded as withdrawn alive at that point. Each year of follow-up was counted as a separate observation (1 person-year) for each participant. For example, an individual who was followed up for 10 years and died during the 10th year would contribute a total of 10 person-year observations to the data set. For each of these person-years, we coded the outcome variable as "1" if the person committed suicide during that year and "0" otherwise. Except for year since injury, all the other predictors were time-invariant variables, whose values did not change across the person-years for the same participant. For each categorical predictor in the logistic regression model, we provided a *P* value of global Wald test, and a 95% confidence interval of odds ratio for each category.

We next calculated standardized mortality ratios (SMRs) for each cohort by using the U.S. general population as the anchor. There are 2 reasons to use the SMR method. First, the crude suicide rates may overestimate the actual effect of SCI because of the disproportionally larger high-risk group—that is, males in the SCI population.[2] Second, SMRs can present the differences between persons with SCI and the general population regarding suicide mortality. We calculated the SMR as a ratio of the number of observed deaths in our SCI sample to the number of expected deaths if our SCI sample had the same suicide mortality rate as the general population. The total number of deaths expected was estimated separately for each cohort by applying the age-sex-race−specific suicide mortality rates for the general U.S. population. We retrieved the U.S. suicide mortality rates from the Centers for Disease Control and Prevention.[22] We used the suicide mortality rates of the U.S. general population in 1982 for the first injury cohort SMR calculation, the mortality rates in 1990 for the second injury cohort, and the rates in 2000 for the third injury cohort because they are the midyear of follow-up for each cohort. All analyses were conducted using SAS version 9.3.[a]

Results

We identified a total of 31,339 participants injured between January 1, 1973, and December 31, 1999. Among them, 5124 were injured between 1973 and 1979, 12,120 between 1980 and 1989, and 14,095 between 1990 and 1999. The demographic and injury characteristics of each injury cohort are shown in table 1.