

# Traumatic spinal cord injury in Hawaii

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*As a prelude to continuing surveillance in Hawaii, a 2-year retrospective study (1987-1989) was conducted by the Pacific Basin Rehabilitation Research & Training Center (PBRRTC) and the Rehabilitation Hospital of the Pacific (REHAB) in order to examine the frequency and causes of traumatic spinal cord injury (SCI) at REHAB; determine similarities and differences when compared to national statistics and make recommendations for future study. Data were abstracted from patient records at REHAB. During the period of study, 59 persons were treated for SCI. Similar to the national database, 85% were males and 70% were teenagers and young adults. Motor Vehicle Accidents (MVAs) contributed to 38% of the injuries followed by falls (28%), sports (19%) and violence (16%); however, etiology differed according to age. Sixty-two percent of the lesions were cervical. Almost 50% were neurologically complete. Sixty-six percent were in wheelchairs. Over 50% were independent in mobility and feeding and nearly 40% were independent in bathing and dressing. Eighty-eight percent returned to their homes. In general, the case at REHAB did not differ from the national database. Because reporting has not been mandatory, actual SCI incidence in Hawaii is most likely higher. Information derived from a mandatory reporting system would lead to identification of high risk groups, development and evaluation of prevention programs, identification of patients requiring early intervention and rehabilitation, and better planning of health care services.*

## Introduction

Each year, an estimated 10,000 new cases of SCI occur in the United States. Estimates of the incidence of acute traumat-

ic SCI in the United States range between 28-55 injuries per million persons per year<sup>1,2</sup>. A recent study conducted by the Paralysis Society of America<sup>3</sup> estimates that the SCI prevalence rate is 721 cases per million, and that there are approximately 177,000 spinal cord injured persons living in the United States today. One study estimated the prevalence of SCI to be as high as 500,000 Americans<sup>4</sup>. The incidence and prevalence of SCI in Hawaii are not known.

National statistics also indicate that persons between the ages of 15 and 35 are at the highest risk for sustaining an injury to the spinal cord. Traumatic injuries are the leading cause of death in the adolescent age group and the leading cause of potential loss of productive years of life<sup>5</sup>. The impact of these sudden injuries can be devastating to the victims, their families and society as a whole. In addition to the physical disabilities, injured persons and their families are faced with social, emotional, financial and vocational problems. Direct medical costs of these injuries to the federal government are well over \$4 billion per year. Lost earnings associated with SCI are estimated at \$3.6 billion<sup>1</sup>.

Since most SCI is preventable, information available on incidence, causes, hospitalization and outcome measures would be beneficial for the medical community as a whole. The collection of needed information on all causes of SCI (gunshot wounds, stabbings, falls, sports activities such as diving, football, dirt-bike riding, etc) continues to be fragmented at best.

The Rehabilitation Hospital of the Pacific, the only acute comprehensive rehabilitation hospital with a Spinal Cord Injury Program serving the Hawaiian Islands and the Pacific Basin (American Samoa, Guam, Commonwealth of the Northern Marianas, Republic of the Marshall Islands, Federated States of Micronesia, and Republic of Belau), collaborated with the Pacific Basin Rehabilitation Research & Training Center, John A. Burns School of Medicine, University of Hawaii at Manoa (PBRRTC) to initiate a formal study to collect data on patients with SCI.

Our study was intended to: (a) examine the frequency and causes of SCI in Hawaii, specifically at REHAB; (b) compare REHAB cases and the national statistics in demographics, causes and the outcome rehabilitation; and (c) make recommendations for further studies in this area.

## Methods

The national database registry developed by the University of Alabama at Birmingham was selected for data collection as

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the most appropriate registry currently in use. Our data were abstracted from REHAB patient records of persons with SCI admitted during a 2-year period from October 1, 1987 to September 30, 1989.

A registered nurse was trained in the collection of data. In medical records where classification of preserved neurological function was in question, the SCI medical director, a physiatrist, was consulted. Data were then entered into a computer and verified. Descriptive statistics were used to analyze the data.

In addition, results were compared with national data reported in *Spinal Cord Injury: The Facts and Figures*<sup>6</sup>. This publication includes data from 17 model SCI regional systems throughout the United States and has data on 9,647 individuals. Chi square techniques were applied to determine whether differences existed in the frequencies observed and partitioning methods were used to identify the categories contributing to those differences.

**Results**

Our study revealed that 59 persons with SCI had been treated at REHAB. Most of the injuries occurred in the Hawaiian Islands; only 4.8% of the injuries occurred in the Pacific Basin. Men were predominantly the ones injured (84.7%). The 5:1 male-to-female ratio observed at REHAB is within the range (from 3:1 to 8:1) reported by other investigators.

SCI occurred most frequently in the 16 to 30 year olds, ie the majority (44.8%). The mean age was 20.2 years. The dis-

tribution of SCI by age at REHAB and in the national database is shown in Table 1. There were no statistically significant differences between the two groups.

Figure 1 compares the ethnic distribution of REHAB SCI patients to the overall 1987 Hawaii population. Although it appears that Japanese were at lower risk, there is no statistically significant difference between the groups.

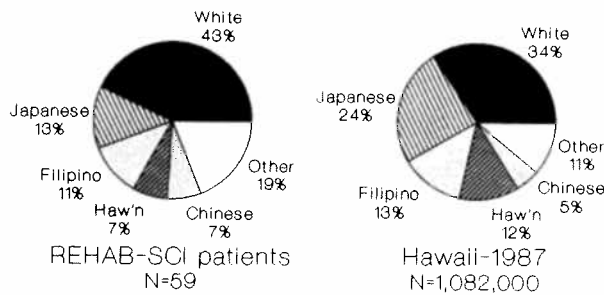
The national database classified the causes of SCI into five major categories: (a) Motor vehicle accidents (MVAs), (b) falls, (c) acts of violence, (d) recreational and sporting activities, and (e) other activities. Table 2 displays the distribution of SCI by etiology at REHAB and in the national database. It appears that REHAB had fewer MVA cases and more falls and sports injuries than nationally; however, there were no statistically significant differences between the two databases.

Automobile accidents accounted for the vast majority (81.1%) of MVAs, followed by motorcycle accidents (13.6%) and bicycle accidents (4.5%). Acts of violence included mostly gunshot wounds (67%). Person-to-person combat (22%) and stabbing (11%) accounted for the other violence-related injuries. The recreational injuries were primarily due to water-related activities. Sixty-four percent occurred while diving into water, and 9% while surfing (includes body surfing).

Age can be a factor in the etiology of SCI. In the age group 45 and older, falls were the leading cause of SCI, followed by MVAs. The causes of SCI in the 31 to 45 year age group were equally distributed between the 4 categories. More than half of the SCI occurring in the 16 to 30 age group was caused by MVAs, the remaining injuries distributed evenly in the remaining categories. Injuries to the under 15-year olds occurred almost exclusively during recreational sporting activities or were the result of falls.

The neurological level of the lesion most frequently observed at REHAB based on diagnosis at the time of discharge was the 5th cervical segment, followed by lesions at the 4th and 6th cervical segments. The next most frequently observed lesion was at the T4. Cervical lesions accounted for more than 60% of the injuries. Thoracic lesions accounted for approximately 29% and lumbar lesions accounted for a relatively low number of injuries (8.1%). The distribution of preserved neurological levels at REHAB and in the national database is shown in Table 3. There were no statistically significant differences between the two databases.

Figure 1. Comparison of Ethnic Distribution for Hawaii and SCI patients



Age at Injury	REHAB N=59	National N=9,647
0-15 years	5.2%	4.9%
16-30 years	44.8%	61.1%
31-45 years	25.9%	19.4%
46-60 years	12.1%	9.2%
61-90 years	12.1%	5.4%

Table 1: Distribution of SCI by Age at Injury

Etiology	REHAB N=59	National N=9,647
MVA	37.9%	47.7%
Violence	15.5%	14.6%
Sports	19.0%	14.2%
Falls	27.6%	20.8%
Other	0%	2.7%

Table 2: Distribution of SCI by Etiology

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The American Spinal Cord Association (ASCA) adopted a classification scheme, the Frankel Grading System, to describe the neurological extent of injury. It consists of the following categories: A. Complete — all motor and sensory function is absent; B. Incomplete, preserved sensation only — preservation of any demonstrable, reproducible sensation — voluntary motor functions are absent; C. Incomplete, preserved motor non-functional — preservation of voluntary motor function which is minimal and performs no useful purpose; D. Incomplete, preserved motor functional — preservation of voluntary motor ability below the level of injury which is functional; E. Complete return of all motor and sensory function, but one may still have abnormal reflexes<sup>7</sup>. The distribution of SCI by Frankel Grades observed at REHAB were similar to those reported in the national database. At REHAB, half (50.8%) of the SCIs were neurologically complete (A) and one third (35.6%) were motor functional (D), whereas in the national database the distribution was 51.1% and 29.6% respectively.

**Outcome**

An important outcome of rehabilitation is the level of functional performance in mobility and self-care skills. Although

	REHAB N=59	National N=9,647
<b>Level Preserved</b>		
High Quad (C1-4)	16.2%	16.5%
Low Quad (C5-8)	45.9%	36.7%
High Thoracic (T1-6)	18.9%	13.5%
Low Thoracic (T7-12)	10.8%	21.1%
Lumbar (L1-5)	8.1%	10.1%

Table 3: Distribution of SCI by Level Preserved

this information was collected using the national database registry, at REHAB more specific information was obtained and recorded about the level of dependence in a variety of situations. These data are presented in Table 4. One-third of the patients were ambulatory (32.2%) and approximately two-thirds required the use of wheelchairs.

The distribution of SCI according to methods of urinary bladder management in the two databases is displayed in Table 5. The databases showed significant differences between the indwelling, intermittent catheterization program (ICP), condom and continent bladder management methods.

The average number of days SCI patients were hospitalized in prior acute care facilities was 28.6 days and ranged from 6 to 78 days. The average number of days at REHAB was 59.4 days. The range was from 5 to 199 days. Five of the patients spent an average of 23 days additionally in prior skilled nursing level and 2 of these had also spent an average of 7.5 days in intermediate care level.

In order to compare this data with the national database, which contains SCI systems, the number of days hospitalized in acute care must be combined with the number of days at

	REHAB N=59	National N=9,647
<b>Bladder Management</b>		
Indwelling	0%	16.6%
ICP	57.6%	30.1%
Condom	8.5%	21.7%
Suprapubic	0%	7.7%
Continent	33.9%	15.2%
Other	0%	8.7%

Table 5: Distribution of SCI by Bladder Management

Level	Function				
	Bed Transfer	Mobility	Bathing	Dressing	Feeding
Total Dependence	5.7%	1.9%	3.8%	5.8%	2.0%
Human Assistance	15.4%	11.5%	32.7%	42.3%	31.4%
Supervision	25.0%	30.8%	21.2%	13.4%	4.0%
Assistive Device	28.8%	40.4%	40.4%	38.5%	27.4%
Independent	25.0%	15.4%	1.9%	0%	37.3%

Table 4: Distribution of SCI by Function

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REHAB. The average number of combined days was 116.8 days, as compared to 100 days in the national database. The difference is not statistically significant.

The place of residence at discharge in both the REHAB and national databases was identical. A large majority (88.1% at REHAB and 91.9% nationally) was discharged to private residences, in most cases their homes prior to injury. The remaining patients were discharged to nursing homes, other hospitals, or to group homes.

#### Summary and discussion

In general, the population treated at REHAB resembles the population in the national database. SCI primarily involved male teenagers and young adults. MVAs contributed to the most injuries followed by falls, sports, and violence; however the age of the victim was a factor. Cervical lesions accounted for most of the injuries. Half of the injured were neurologically complete and one-third were motor functional. Two-thirds of those injured required the use of wheelchairs. More than half were independent (with or without assistive devices) in mobility skills and feeding. Nearly 40% were independent (with assistive devices) in bathing and dressing. The majority of those injured returned to their homes.

Differences between REHAB and the national database existed in the methods of bladder management. The bladder management methods used at REHAB reflect the more recent, acceptable and preferred methods, the figures from the national database were collected prior to 1986. The higher percentages at REHAB of ICP may be a factor in a lower incidence of upper urinary tract deterioration and kidney failure. It should also be noted that many patients are on both ICP and condom drainage at the time of discharge. The lower percentage of condom drainage methods at REHAB may also be a factor resulting in increased continence; it is the preferred method.

Ideally, our study would also have examined the frequency and the causes of SCI in the whole State of Hawaii, instead of just at REHAB. Therefore, several cautionary notes must be considered. Due to the lack of mandatory reporting by law of SCI in the State, the actual incidence is most likely higher than that noted in this report. Of the 59 persons with spinal cord injury presented in the study, 3 persons were from Pacific Island countries; 56 persons listed Hawaii as their place of residence. Although the frequency of SCI appears to be 28 per million in Hawaii, which would be within the range of national statistics, several groups are excluded from this sample. These groups include the following: tourists who sustain spinal cord injuries and prefer to return to their home state or native country for comprehensive inpatient rehabilitation; active and/or retired military and their dependents who may be stabilized then transferred to a military base hospital or Veteran's Hospital in the continental United States; and patients on a specific, managed-care insurance plan that does not pay for inpatient rehabilitation outside of its hospital system.

Despite the limitations of this study, comparison of this project's statistics with those available nationally is a necessary first step towards injury surveillance, and, eventually, measuring the impact of our existing prevention programs,

such as the Spinal Cord & Head Injury Project (SCHIP). A review of current SCI registries and surveillance systems nationwide indicates that there are presently 11 states with a legislative mandate for reporting. There has also been a concerted effort by the Centers for Disease Control (CDC) and the Council for State & Territorial Epidemiologists (CSTE) to have SCI listed as the first injury condition reportable to state health agencies and the CDC. The rationale for selecting SCI for injury surveillance was due to the seriousness of these injuries and the potential for their prevention. It was also considered a practical choice because the number of cases is small enough to be manageable, and a consensus could be reached on case definition.

Although there is no formal reporting requirement of SCI in Hawaii, several agencies collect trauma-related information. The State Department of Health is developing an integrated data base to evaluate the effectiveness of the Emergency Medical System's response to trauma resulting from all causes of injury. Acute care hospitals are participating in this project; this will provide a pool of information.

By supporting mandatory reporting by law of SCI in our State, a more comprehensive profile would be available on this devastating catastrophic disability. Information generated from such a SCI surveillance could accomplish several objectives: (a) Identify patients that require early intervention and a comprehensive rehabilitation program, beginning at the onset of the injury in order to maximize functional levels of independence; (b) evaluate and monitor patient outcome; (c) plan for long-term follow-up of health care needs; (d) identify high risk groups and evaluate the effectiveness of existing prevention programs; and (e) develop new programs earlier in the educational curriculum of the schools as a preventive measure.

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#### REFERENCES

1. Morbidity & Mortality Report Weekly. *Massachusetts Medical Society* 37(18), 1988.
2. Collins, WF, Piepmeier, J. & Ogle, E. The spinal cord injury problem—a review. *Central Nervous System Trauma* 3(4): 317-331, 1986.
3. Estimates of SCI prevalence. *Paralysis Society of America Research Briefs* January, 1990.
4. Green BA, Eismont FJ & O'Heir JT, Spinal cord injury — a systems approach: prevention, emergency medical services, and emergency room management. *Critical Care Clinician* 3(3): 471-493, 1987.
5. Paulson, J.A. The epidemiology of injuries in adolescents. *Pediatric Annals* 17(2): 86-96, 1988.
6. Kennedy, E.J., Stover, S.L. & Fine, P.R. (eds.). *Spinal Cord Injury: Facts and Figures*. Birmingham, AL: University of Alabama, 1986.
7. American Spinal Injury Association: *Standards for Neurological Classification of Spinal Injury Patients*, 1989.