spinal cord injury in wisconsin
1998

September 2000

Wisconsin Department of Health and Family Services
Division of Supportive Living
Bureau of Aging and Long Term Care Resources
Office for Persons with Physical Disabilities

Supported by grant H133N50024 of the Model Spinal Cord Injury System from the National Institute on Disability and Rehabilitation Research, Office of Special Education and Rehabilitative Services, U.S. Department of Education, Washington, D.C.

acknowledgements

This research was supported in part by grant H133N50024 of the Model Spinal Cord Injury System from the National Institute on Disability and Rehabilitation Research, Department of Education, Washington, D.C.

Co-Principle Investigators:
Dennis Maiman, M.D., Ph.D
Department of Neurosurgery

Irma G. Fiedler, Ph.D.
Department of Physical Medicine and Rehabilitation

Medical College of Wisconsin
9200 W. Wisconsin Avenue
Milwaukee, WI 53226
(414) 259-2126

Report Author:
Holly Laux O'Higgins
Office for Persons with Physical Disabilities

Contact Information:
Wisconsin Spinal Cord Injury Database
1 West Wilson Street, Room 450
PO Box 7851
Madison, WI 53707-7851
(608) 266-8905 Voice
(608) 267-9880 TTY
(608) 267-2913 Fax
lauxhm@dhfs.state.wi.us

Alternate format versions of this report are available on request.

table of contents

preface

report

appendices

list of tables and graphs

report

Appendices

preface

Introduction
Introduction to Spinal Cord Injury
Registry Background
Data Sources

introduction

The establishment of a statewide database and surveillance program was necessary to clearly identify factors and demographics of the population of individuals who sustain spinal cord injuries (SCIs).

This report represents an overview of spinal cord injuries in Wisconsin occurring in 1998 including incidence, prevalence and economic information. Data presented in this report are drawn from hospital discharge data with ICD-9-CM diagnostic codes 806.00-806.99 (fracture of vertebral column with spinal cord injury) and 952.00-952.99 (spinal cord injury without evidence of spinal bone injury). These codes were chosen based on Center for Disease Control and Prevention Guidelines.

With these data it is possible the same person could be hospitalized more than once during 1998. To avoid counting duplicate hospital visits, only the initial hospital visit data is included in the report, except for the "length of stay" and "cost of stay" data. These exceptions were figured from all hospital visits resulting from the original injury to give the actual length of stay and cost of stay data for each injury.

The discharge data presented here include all events occurring in Wisconsin during 1998 to Wisconsin residents only. Non-residents of Wisconsin were not included. Hospital discharge data were provided by the Wisconsin Bureau of Health Information under a confidentiality agreement with the Office for Persons with Physical Disabilities (OPPD).

Readers are encouraged to review the entire report and tables before drawing conclusions. Please contact the Office for Persons with Physical Disabilities for further explanation of the data presented in this report or for additional copies.

Wisconsin Spinal Cord Injury Database
Office for Persons with Physical Disabilities
Bureau of Aging and Long Term Care Resources
Division of Supportive Living
Department of Health and Family Services
P.O. Box 7851
Madison, WI 53707-7851

background

In 1995 the Medical College of Wisconsin received a five-year grant from the National Institute on Disability and Rehabilitation Research, Department of Education to become a federally designated Model Spinal Cord Injury Center. As an integral component of the grant, the Department of Health and Family Services, Office for Persons with Physical Disabilities received a subcontract to establish an SCI surveillance database. The database compiles statewide hospital discharge data about persons sustaining SCIs. These data will enable other investigators to design and implement prevention and service projects, to assist individuals with SCIs to live at their maximum levels of independence in their communities.

The objectives of the Spinal Cord Injury Surveillance include:

- contribute to and compare Wisconsin data with the national SCI data base,
- identify and track the incidence of spinal cord injury in Wisconsin,
- provide data to facilitate the development and implementation of effective preventive programs, and
- identify and track the expenditure of treatment and service dollars for persons who are spinal cord injured.

data sources

The 1987 Wisconsin Act 399 established the Bureau of Health Information (BHI), formerly known as the Office of Health Care Information (OHCI). BHI's responsibilities include collecting, analyzing and disseminating information on health care from inpatient hospital medical records. Under the statute and administrative rules, hospitals are required to submit specific data to BHI to construct an inpatient hospital database, using information currently being collected on the Uniform Billing forms (UB-92). Along with a patient's billing information, the diagnosis and treatment of the patient are recorded using standard International Classification of Disease-9th Revision-Clinical Modification (ICD-9-CM) codes.

Hospitals reporting spinal cord injuries in 1998 are shown in Table 1.2 and the diagnoses used are shown in Table 1.3, both in Appendix 1.1.

The case definition used for this analysis is consistent with current Centers for Disease Control (CDC) guidelines for SCI surveillance. These are the ICD-9-CM codes 806.0-806.9 (fracture of vertebral column with spinal cord injury) and 952.0-952.9 (spinal cord injury without evidence of spinal bone injury). This report does not include persons with SCI who died before reaching a hospital.

Data collected from BHI also includes external cause codes (E Codes) which classify causative agents and/or activities for disabling injuries. E-codes provide crucial information to guide, develop and evaluate interventions and initiate prevention activities. E-codes are in Table 1.4.

data security

The SCI database maintains confidential data on individuals. These data are only accessible to the subject of the data and to the data analyst. Measures to retain patient confidentiality are outlined in Wisconsin Statues Chapter 153.45 (Release of Data) and 153.50 (Protection of Patient Confidentiality). Only summary data are accessible to the public to protect individual identities.

All data are protected electronically through password measures. Copies of data on backup diskettes are kept under lock and key by the analyst at OPPD. An automatic virus-checking program safeguards against virus data corruption.

data quality

While analyzing these data, questions arose relevant to the validity of coding by hospitals of SCIs resulting in permanent neurological deficit necessitating an inpatient rehabilitation stay. An SCI with permanent neurological deficit is one in which the individual becomes paralyzed including tetraplegia, paraplegia or has paralysis of bowel and bladder functions.

In the American Journal of Epidemiology, Vol. 146, pp 266-272, 1997, Johnson et al. raised the issue of accuracy in reporting of SCI to a statewide database in Colorado. They report a positive predictive value of 0.55, implying that one can be only 55 percent certain that an identified case of SCI resulted in permanent neurological deficit. This affects the surveillance aspects of any database planning to record only SCIs with permanent neurological deficit. It is important to remember that the Center for Disease Control only requires a code of 806 or 952 for the national database.

While full medical chart review of all reported cases is not feasible due to cost, time and confidentiality, an attempt is underway to screen data using available codes via a process developed by the Medical College of Wisconsin Model SCI Center. Diagnoses critical to SCI include acute paraplegia or quadriplegia, bowel and bladder paralysis and systemic problems typically associated with SCI. Procedure codes incorporated in the determination of neurological deficit include the performance of surgery for decompression or stabilization of the spine, placement of a halo and transfer into a rehabilitation environment. Lengths of stay and outcome data were also considered: if patient demonstrated transient quadriparesis, or was discharged home after one day of inpatient hospital care, it was clear that this was not a permanent neurological deficit.

To verify this process, a random, limited comparison of the results with actual medical records was completed for patients discharged from Froedtert Memorial Lutheran Hospital. Eighty-six percent of the determinations at Froedtert were found to be correct. See Appendix 1.4 for an abstract describing the study.

wisconsin’s population

Tables 1.6 and 1.7 in Appendix 1.3 summarize Wisconsin's population by county of residence and age. From 1990 census data, Wisconsin's estimated 1998 population was approximately 49 percent male and 51 percent female. The largest population age group for both males and females was 18 - 44, comprising 40 percent of the general population. Ages 0-17 (26%), 45-64 (21%) and 65+ (13%) followed (Wisconsin Department of Health and Family Services, 2000).

Table 1.6 in Appendix 1.3 shows SCI events by county of residence in 1998. These data reflect the county in which the person lives, not necessarily the county in which the SCI occurred. As expected, counties with greater population rates had a higher number of injury events occurring to their residents.

introduction to spinal cord injury

The spinal cord is part of the nervous system and is the largest nerve in the body. It is approximately 18 inches long and extends from the base of the brain, down the middle of the back, to the waist. The spinal cord is surrounded by protective rings of bone called the vertebral column, or spinal column. The 33 vertebrae of the spine are divided into several regions.

The cervical spine in the neck area consists of seven vertebrae and eight nerve roots. They are smaller than other vertebrae, allowing for greater movement. The thoracic spine, at chest level, has 12 vertebrae and nerve roots. The spinal canal in the thoracic region is relatively smaller than the cervical or lumbar areas, putting the thoracic spinal cord at greater risk if there is a fracture (Maddox, 1993). The lumbar spine, in the low back region, has five vertebrae and nerve roots. The sacrum also has five fused vertebrae and nerve roots. The coccyx, or tailbone, has one vertebrae and nerve root. Vertebrae increase in size as they go down the column.

The central nervous system consists of the brain and spinal cord. The nerves in the spinal cord are upper motor neurons and their function is to carry the messages back and forth from the brain to the spinal nerves along the spinal tract. The peripheral nervous system consists of lower motor neurons, spinal nerves that branch out from the spinal cord to other parts of the body. These spinal nerves exit and enter at each vertebral level and communicate with specific areas of the body. The sympathetic nervous system is a system of nerves controlling involuntary functions such as blood pressure and temperature regulation.

Spinal cord injury (SCI) refers to any injury of the neural elements within the spinal column. SCI can occur from trauma or disease to the vertebral column or the spinal cord. Most SCIs result from trauma to the vertebral column. The spinal cord does not have to be severed for a loss of functioning to occur. Most people with SCI have an intact spinal cord, but the damage to it results in loss of functioning due to bruising or loss of blood supply. These injuries can affect the spinal cord's ability to send and receive messages from the brain to the body systems controlling sensory, motor and autonomic function below the level of injury.

Typically, the nerves above the injury site continue to function normally but the nerves below the site do not. A physician describes an individual as having a certain “level” injury by naming the region affected and the level that corresponds with that region. In general, the higher the level of injury, the greater the functional loss. Damage to the cervical region (C1-C8) usually results in a loss of function in the arms and legs, resulting in tetraplegia. Injury to the thoracic region (T1-T12) usually affects the chest and legs and results in paraplegia. Nationally, the most common types of injury are at the mid-to-low cervical vertebrae (C5-C6), followed by the thoracolumbar junction (T2-L1). Both spots are the spine’s areas of greatest flexibility and vulnerability.

report

executive summary

In 1998, there were 259 SCI events in Wisconsin with falls and motor vehicle accidents as the predominant causes of hospitalization. Males disproportionately represent 80 percent of SCI events.

- The average age at time of injury was 42.6 (males 40.7 and females 49.8), with the most frequent age at 42 for males and 45 for females.
- Males ages 18-44 represent the overall largest group of injury with 122 (47% overall) injuries, followed by men in the 45-64 age group with 42 (16% overall) injuries.
- Females ages 18-44 represent the largest group of women with 21 (8%) injuries and women older than 65 represent the next largest group for women with 17 (7% overall) injuries.
- Overall, 143 (55%) injuries (both men and women) occurred between the ages of 18-44.
- It is interesting to note that 19 (42%) of all injuries occurred to individuals age 61 or older.

SCI can result in paraplegia or tetraplegia. Forty-three percent (111 injuries) of all SCIs resulted in tetraplegia, 95 (37%) to men and 16 (6%) to women. Ninety-one injuries (35%) resulted in paraplegia, 69 (27%) to men and 22 (8%) to women. See Graph 1.10, page 27.

Although age and gender are significant risk factors for spinal cord injury, there are other risk factors that contribute such as race, time of year and demographic area. The majority of individuals admitted for SCIs during 1998 were white (183 or 71%), followed by African Americans with 38 (15%) injuries. Although whites sustain the majority of spinal cord injuries, members of minority groups sustain a disproportionate percentage relative to their numbers. African Americans comprise approximately 5% of Wisconsin's population (1990 Census).

Late spring and early summer had the highest number of spinal cord injury events, with 26 in May and 34 in June. Saturday and Sunday had the highest incidence of spinal cord injuries with 94 (36%).

The average length of an inpatient hospital stay in 1998 was 16.9 days. In 1998, hospital charges for treatment for SCIs totaled more than $11 million. In 1990 the overall cost also totaled more than $11 million. Since 1990, which had an SCI incidence of 204 compared with 1998's SCI incidence of 259, there has been a 48% decrease in the average length of inpatient stay. The average cost for an acute inpatient hospital stay has decreased from $55,542 in 1990 to $42,838.36 in 1998.

In 1998, 76% (196) of initial inpatient stays were paid by fee for service insurance. Eighty (31%) initial inpatient stays were paid for by an Alternative Health Care Insurance Plan (HMO, PPO, PPA, etc.) (see Graph 1.8, page 24). This represents a 15% increase over 1990 to 1994, during which fee for service insurance paid 61% of SCI inpatient stays and Alternative Health Care Insurance Plans paid 11% of inpatient SCI stays.

Spinal cord injuries have profound effects on the public health system because of the young age of those injured, the high cost of acute and rehabilitative care, and the long-term disability.

spinal cord injury events: 1998

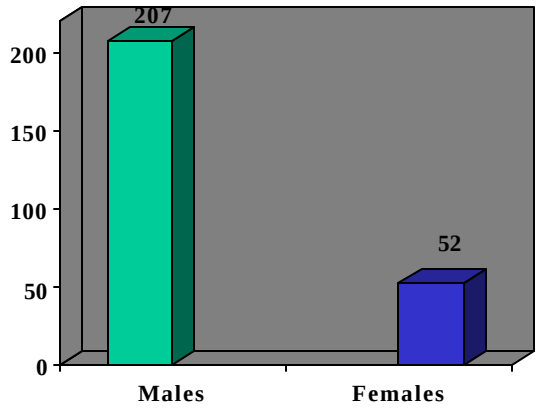
The Incidence of Spinal Cord Injury

From January 1, 1998 to December 31, 1998, a total of 259 Wisconsin residents were hospitalized for an SCI.

Demographics

Sex
Males sustained 207 injuries (80%) and females sustained 52 injuries (20%) (Graph 1.1).

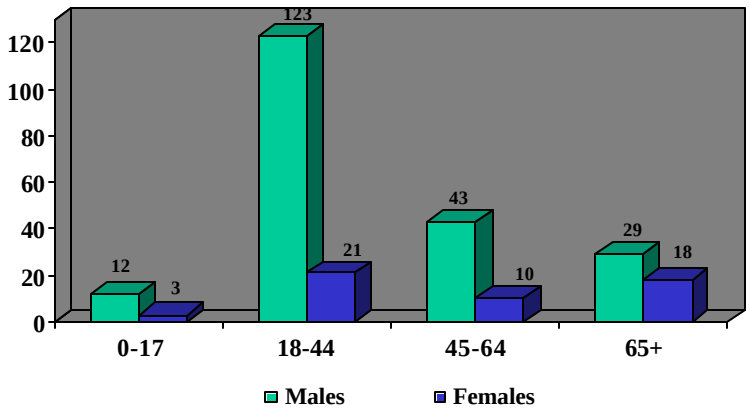
Graph 1.1
Injuries by Gender and Year
1998



Age
The average age at time of injury was 42.6. The mean age at injury was slightly higher for females (45) than for males (42). Ages range from 4 to 93.

- Males aged 18-44 represent the overall largest group of injury with 123 (47%) injuries, followed by men in the 45-64 age group with 43 (17%) injuries.
- Females aged 18-44 represent the largest group of women with 21 (8%) injuries, followed by women 65 and older with 18 injuries (7%) (Graph 1.2).

Graph 1.2
Injuries by Age and Gender
1998



Overall, 55% of all injuries occurred to individuals between the ages of 18-44. The next highest age group was 45-64, with 51 (20%) of all injuries. Eighteen percent occurred to individuals aged 65 and older and 7% of all injuries occurred between the ages of 0-17. The total number of spinal cord injuries for each age group and gender is listed in Table 1.1 on page 26.

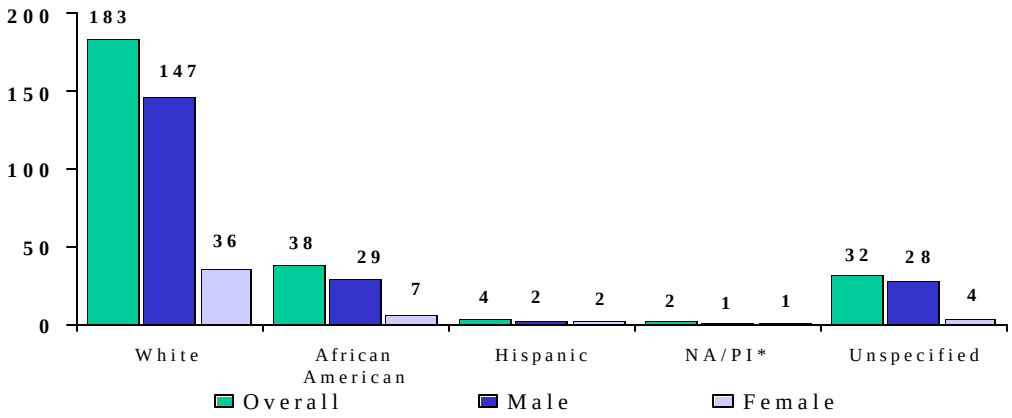
Among racial/ethnic groups, whites had the highest mean age at injury (45.3 years), while Hispanics have the lowest mean age at injury (22.5 years). The mean age at injury for African Americans is 39.3 years.

Ethnicity

The race of some patients in 1998 was unknown or documented as "other" or was otherwise unspecified (32 or 12%). The majority of individuals admitted for SCIs during 1998 were white (183 or 71%), followed by 38 (15%) for African Americans, 4 (1.5%) for Hispanics and 2 (.8%) for Asian/Pacific Islanders and Native Americans (Graph 1.3).

Although whites sustained the majority of spinal cord injuries, members of minority groups did sustain a disproportionate percentage relative to their numbers in Wisconsin. In fact, 5% of Wisconsin's population is African American, yet this group sustained 15% of all spinal cord injuries in Wisconsin.

Graph 1.3
Injuries by Race
1998



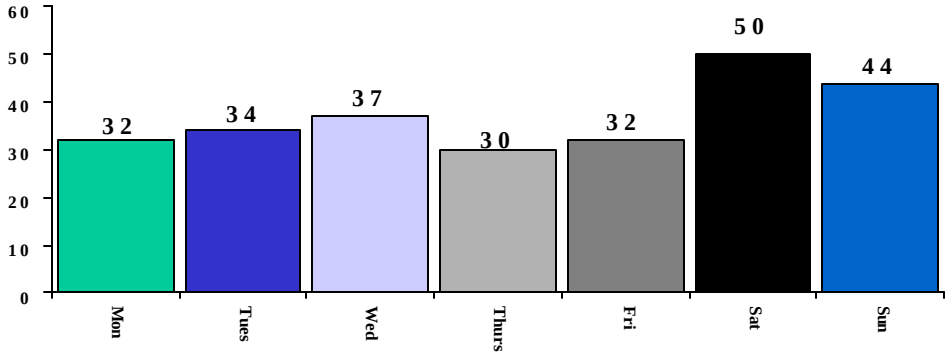
*NA/PI = Native American/Pacific Islander

Hospitalization and Cost Information

Admission Day, Month, Type and Source

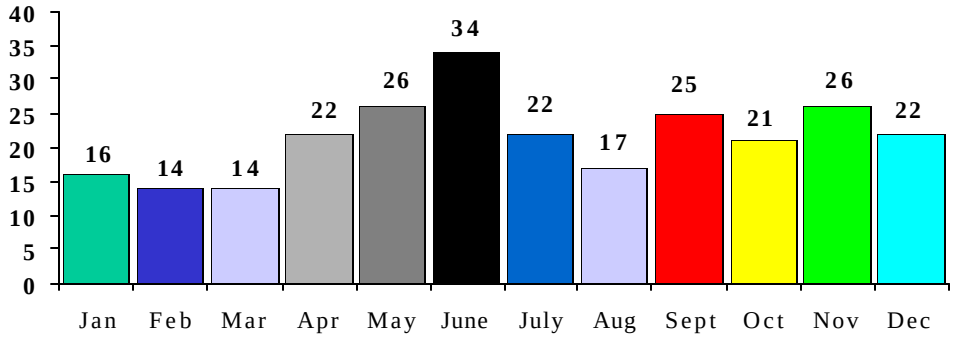
In 1998, the majority of SCI events occurred during the weekend. Saturdays had the highest number of events with 50 (19%) while Thursdays have the lowest number of injury events with 30 (12%) (Graph 1.4).

Graph 1.4
Admission by Day of the Week
1998



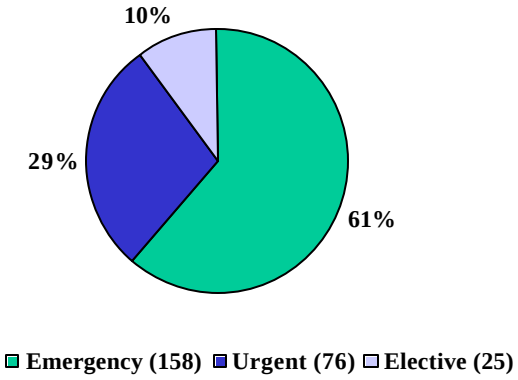
The highest number of injuries during one month, 34, occurred during June followed by 26 injuries each in May and November. February and March had the lowest number of injuries with 14 each (Graph 1.5).

Graph 1.5
Admission by Month
1998



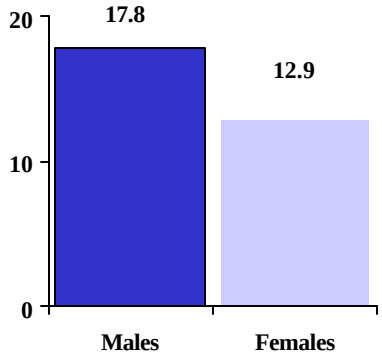
Both the largest type and source of admission to hospitals involving residents with SCIs occurred during emergency situations, when the patient required immediate medical intervention as a result of severe, life threatening or potentially disabling conditions (Graph 1.6).

Graph 1.6
Type of Admission
1998



Length of Inpatient Stay
The average length of an acute inpatient hospital stay in 1998 was 16.9 days. The average length of stay for men was 17.8 days, for women 12.9 days (Graph 1.7). The length of inpatient stay has decreased 48% since 1990 when the overall average length of stay was 35.2 days, 36.5 for men and 31.5 for women. The average length of stay for a tetraplegia injury was 14 days and for a paraplegia injury, 15 days.

Graph 1.7
Average Length of Inpatient Stay by Gender
1998



Cost of Inpatient Hospital Care
In 1998, acute care hospital charges for treatment of spinal cord injury totaled more than $11 million. In 1990 the overall cost also totaled more than $11 million. Since 1990, which had an incidence of SCI in Wisconsin compared with the 1998 incidence of 259, there has been a 48% decrease in the average length of inpatient stay. The average cost for an acute inpatient hospital stay has decreased from $55,542 in 1990 to $42,838.36 in 1998.

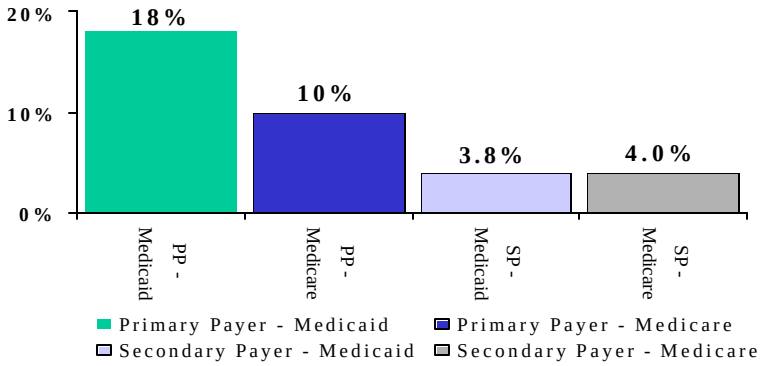
The cost of hospitalization was greater for males than females. In 1998, males averaged $43,900.70 per year, females averaged $38,609.40 per year, down from an average cost of $59,597 for men and $43,986 for women in 1990. Thirty-one percent of all injuries to females (16) resulted in tetraplegia, while 46% of injuries (95) to males resulted in a tetraplegia diagnosis. It is important to remember that these costs do not reflect the total cost for a spinal cord injury, because medical equipment, ongoing medical care, home and vehicle modifications and attendant care add to the overall costs of spinal cord injuries.

Payer Type
In 1998, the majority of initial inpatient stays (196 or 76%) were paid for by fee-for service insurance. Eighty (31%) initial inpatient stays were paid for by an Alternative Health Care Insurance Plan (HMO, PPO, PPA, etc.). Other payment types included worker's compensation (15 or 6%), general relief (2 or .8%), other government agency or program (13 or 5%), and self-

pay (94 or 36%). For 9 (3%) inpatient stays, the exact type of payment, either fee-for-service or HMO was unable to be determined (Graph 1.8).*

*Percentages add to more than 100 because numbers are based on primary and secondary payer information.

Graph 1.8
Primary and Secondary Payers
1998



Primary and Secondary Payer

Medicare was the primary payer for 46 (18%) initial inpatient stays; Medicaid for 27 (10%) stays. Medicare was the secondary payer for 10 (3.8%) initial hospital stays; Medicaid for 11 (4%).

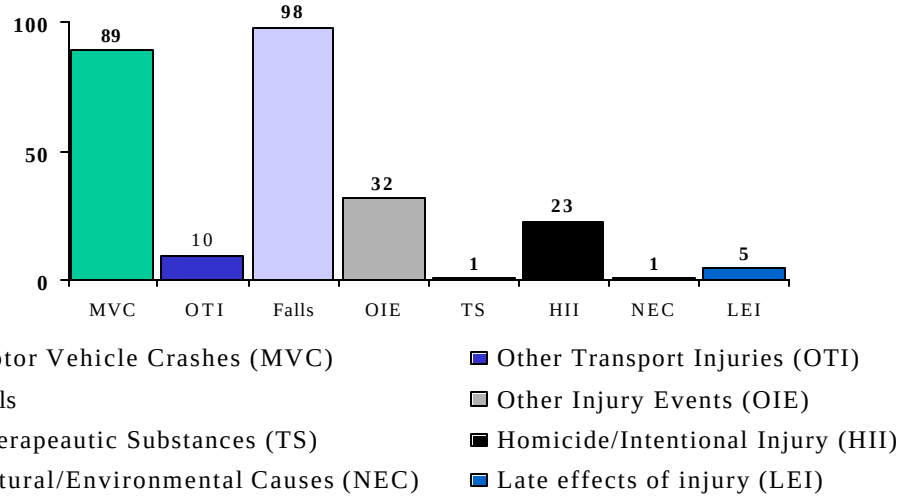
Causes of Injury

Based on E-Codes, the leading cause of SCI during 1998 was falls (98), followed by motor vehicle crashes (89), and then other injury events (25) such as sports accident or being struck by an object or person. Motor vehicle crashes were the leading cause of injury to those aged 0- 45 (61 or 24%). After age 46, the leading cause of injury was due to some type of fall (56 or 22%) (Graph 1.9).

Accidental falls were the leading cause of injury overall. They represent 72 injuries to whites (28% overall) and 17 injuries to African Americans (6.5% overall). Of all injuries to whites, accidental falls represent 39%. Of all injuries to African Americans, accidental falls represent 45%. The second leading cause of injury to whites was motor vehicle accidents (63 or 24%), representing 34% of injuries to that group. For African Americans, the second leading cause of injury was intentional injuries (assault and self-inflicted injuries) (13 or 5%) which represent 34% of all SCIs to that group.

Graph 1.9

Causes of Injury
1998



The causes of SCIs for 1998 are listed in Table 1.4 in Appendix 1.1.

Table 1.1
Causes of SCI by Selected Age Groups and Gender: 1998

Age Groups and Causes	Total		Male		Female	
	Number of SCI Events	%*	Number of SCI Events	%	Number of SCI Events	%
0-17						
Total All Causes	**15**	**100**	**12**	**80**	**3**	**20**
Motor Vehicle Crashes	2		1		1	
Other Transport Injuries	2		2		0	
Falls	2		2		0	
Other Injury Events	6		5		1	
Homicide/Intentional Injury	3		2		1	
18-44						
Total All Causes	**144**	**100**	**123**	**85**	**21**	**15**
Motor Vehicle Crashes	59		52		7	
Other Transport Injuries	7		5		2	
Falls	38		35		3	
Other Injury Events	19		16		3	
Homicide/Intentional Injury	19		13		6	
Natural/Environmental Causes	1		1		0	
Late Effects of Injury	1		1		0	
45-64						
Total All Causes	**53**	**100**	**43**	**81**	**10**	**19**
Motor Vehicle Crashes	17		14		3	
Other Transport Injuries	1		1		0	
Falls	26		21		5	
Other Injury Events	4		3		1	
Therapeutic Substances	1		0		1	
Homicide/Intentional Injury	1		1		0	
Late Effects of Injury	3		3		0	
65+						
Total All Causes	**47**	**100**	**29**	**62**	**18**	**38**
Motor Vehicle Crashes	11		11		0	
Falls	32		16		16	
Other Injury Events	3		2		1	
Late Effects of Injury	1		0		1	

*Percentages may not add to 100 due to rounding.

Falls

Falls were the leading cause of SCI among Wisconsin residents, comprising 38% of all injuries (98). Males sustained approximately 3 times as many injuries as females. Falls were the leading cause of spinal cord injury for both genders ages 45 and older. Nineteen percent of falls occurred when an individual fell from one level to another while 17% of falls were the result of a slip, trip or stumble (a fall on the same level). Of all falls, 33% occurred to persons older than 65.

Motor Vehicle Accidents

In 1998, motor vehicle accidents (MVAs) were the second leading cause of SCI in Wisconsin and the leading cause of injury to persons of both genders ages 18 to 44. Of the 89 injury events, 78 (88%) resulted in injuries to males and 11 (12%) to females.

In 66% (59) of MVAs, the driver sustained an SCI. The remainder of injuries sustained in an MVA occurred to passengers or pedestrians. All MVA injuries to drivers, except for 5, were to males. Ten (11%) of all MVAs occurred to individuals operating a motorcycle all of whom were males (Table 1.4).

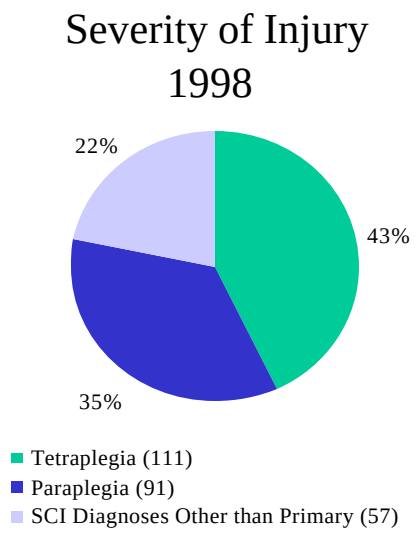
Other Injury Events
This was the third leading cause of injury, not related to transport vehicles, but including injuries incurred during medical procedures, sports injuries and over exertion. Twenty-three injuries (9%) were sustained due to these events.

Homicide/Intentional Injuries
Homicide and intentional injuries were the fourth leading cause of SCI in 1998 with 9% (23) of all injuries. The majority of injuries in this category were due to assault by firearms (12 or 57%), 11 injuries to males and 1 to a female. This category also includes suicide attempts, firearm injuries-intention unknown and fights.

Level and Severity of Injury

There are two categories of spinal cord injuries: paraplegia and tetraplegia. A person is said to have paraplegia when there is a loss of feeling in the lower portion of the body. Tetraplegia is described as loss of movement in both the upper and lower portions of the body (Maddox, 1993). Based on Primary Diagnosis data, 111 (43%) of all SCIs resulted in tetraplegia and 91 (35%) in paraplegia (Graph 1.10). Men sustained 95 injuries (37%) and women 16 (6%) resulting in tetraplegia. Men received 69 injuries (27%) and women 22 (8%) resulting in paraplegia.

Graph 1.10



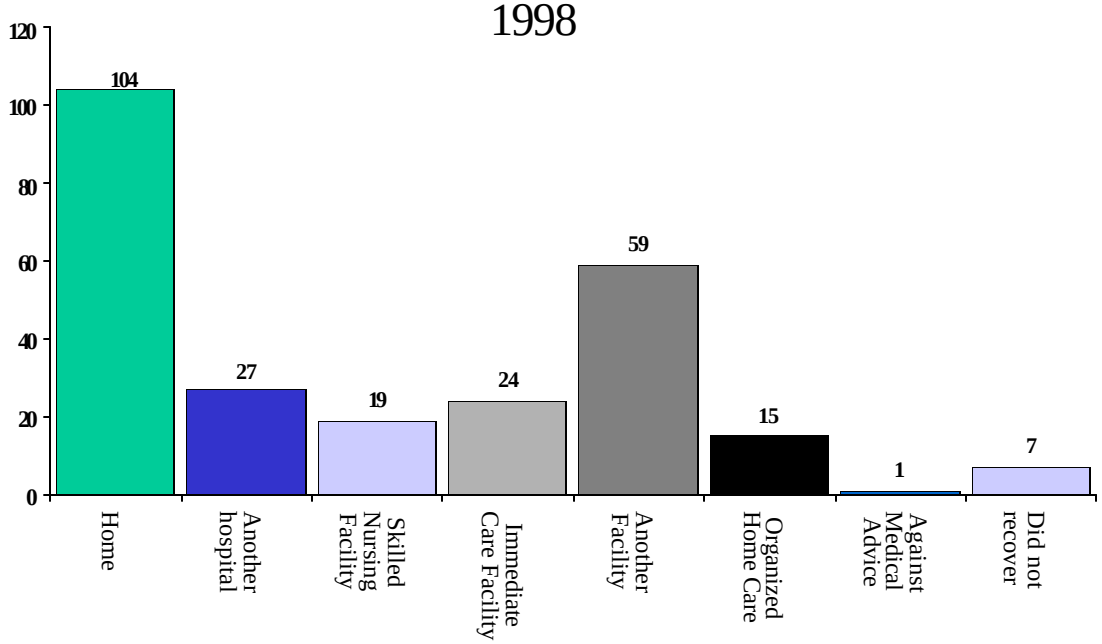
The severity of a spinal cord injury is determined by the level of the injury and by the amount of neurological impairment. A spinal cord injury at any level may impair strength, sensation, bowel, bladder and sexual functioning.

An SCI can also be described as complete or incomplete. With a complete injury an individual has no function, sensation or voluntary movement below the level of injury. In most cases, both sides are equally affected. With an incomplete injury there is some functioning below the primary level of injury and the individual may be able to move one limb more than another, feel parts of the body that cannot be moved, or may have more functioning on one side of the body than the other. Due to advances in medicine, the incomplete injury is more common.

Discharge Location

The majority of SCI patients, 104 or 40%, were discharged to home. Discharges to another facility were the second most common with 59 (23%) discharges (Graph 1.11).

Graph 1.11
Patient Discharge Location
1998



conclusions

The statewide SCI database documents factors and demographics associated with individuals who sustain SCIs. These data indicate major etiologies of injury, the disproportionate injuries sustained by certain age and gender groups and the cost of these injuries.

From these data, the following general conclusions can be made:

- Of those persons older than 65 with a SCI, 12% (32) are from falls. For women, that is 16 injuries or 6% overall and 30% of all injuries to females. For men, that is 16 injuries, 6% overall and 8% of all injuries to males.

- SCI injury resulting from violence and guns has increased from 12 in 1997 to 23 in 1998. This may represent a growing trend toward violence as a major causative factor of SCI.

references

Maddox, S. (1993). Spinal network (2nd ed.). Boulder, CO: Library of Congress Cataloging in Publication Data.

National Spinal Cord Injury Statistical Center (1998). Spinal cord injury: Facts and figures at a Glance. Birmingham, AL: The University of Alabama at Birmingham.

Johnson, R.L., Gabella, B.A., Gerhart, K.A., McCray, J., Menconi, J.C., & Whiteneck, G.G. (1997). "Evaluating sources of traumatic spinal cord injury surveillance data in Colorado." American Journal of Epidemiology, 146(3), 266-272.

Wisconsin Department of Health and Family Services. Spinal Cord Injury: 1990-1994. May 1999.

Wisconsin Department of Health and Family Services. Spinal Cord Injury: 1997. September 1999.

All population estimates

Wisconsin Department of Health and Family Services. http://www.dhfs.state.wi.us/population

appendix 1.1

Hospitals Reporting SCI
Principal Diagnoses
E Codes

hospitals reporting SCI
table 1.2

hospital	city	county
Langlade Memorial Hospital	Antigo	Langlade
Appleton Medical Center	Appleton	Outagamie
St. Elizabeth Hospital	Appleton	Outagamie
Elmbrook Memorial Hospital	Brookfield	Waukesha
Memorial Hospital Corp. of Burlington	Burlington	Racine
Luther Hospital	Eau Claire	Eau Claire
Sacred Heart Hospital	Eau Claire	Eau Claire
St. Agnes Hospital	Fond du Lac	Fond du Lac
Fort Atkinson Memorial Health Services	Fort Atkinson	Jefferson
Bellin Memorial Hospital	Green Bay	Brown
St. Mary's Hospital Medical Center	Green Bay	Brown
St. Vincent Hospital	Green Bay	Brown
THC/Vencor Hospital	Greenfield	Milwaukee
Hartford Memorial Hospital	Hartford	Washington
Mercy Health System Corporation	Janesville	Rock
Kenosha Hospital and Medical Center	Kenosha	Kenosha
Lutheran Hospital – La Crosse	La Crosse	La Crosse
Franciscan Skemp Medical Center, Inc.	La Crosse	La Crosse
St. Mary's Hospital Medical Center	Madison	Dane
University of Wisconsin Hospital and Clinics	Madison	Dane
Saint Joseph's Hospital	Marshfield	Wood
Community Memorial Hospital	Menomonee Falls	Waukesha
Children's Hospital of Wisconsin	Milwaukee	Milwaukee
Columbia Hospital, Inc.	Milwaukee	Milwaukee
Froedtert Memorial Lutheran Hospital	Milwaukee	Milwaukee
Sacred Heart Rehabilitation Institute	Milwaukee	Milwaukee
Sinai Samaritan Medical Center	Milwaukee	Milwaukee
St. Francis Hospital	Milwaukee	Milwaukee
St. Joseph's Hospital – Milwaukee	Milwaukee	Milwaukee
St. Luke's Medical Center	Milwaukee	Milwaukee
St . Michael Hospital	Milwaukee	Milwaukee
Theda Clark Medical Center	Neenah	Winnebago
Mercy Medical Center	Oshkosh	Winnebago
Divine Savior Hospital & Nursing Home, Inc.	Portage	Portage
Saint Mary's Medical Center	Racine	Racine
Saint Mary's Hospital Center	Rhinelander	Oneida
Sheboygan Memorial Medical Center	Sheboygan	Sheboygan
Vernon Memorial Hospital	Viroqua	Vernon

hospital	city	county
Watertown Memorial Hospital	Watertown	Jefferson
Waukesha Memorial Hospital, Inc.	Waukesha	Waukesha
Wausau Hospital	Wausau	Marathon
West Allis Memorial Hospital	West Allis	Milwaukee
St. Joseph's Community Hospital	West Bend	Washington
Howard Young Medical Center, Inc.	Woodruff	Oneida

principal diagnosis
table 1.3

diagnosis code	principal diagnosis	all	male	female
806	**fracture of vertebral column with SCI**			
806.0	**cervical, closed**	**41**	**33**	**8**
806.00	C1-C4 level with unspecified spinal cord injury	6	3	3
806.01	C1-C4 level with complete lesion of cord	3	3	
806.03	C1-C4 level with central cord syndrome	3	1	2
806.04	C1-C4 level with other specified spinal cord injury	3	3	
806.05	C5-C7 level with unspecified spinal cord injury	7	6	1
806.06	C5-C7 level with complete lesion of cord	8	7	1
806.08	C5-C7 level with central cord syndrome	4	4	
806.09	C5-C7 level with other specified spinal cord injury	7	6	1
806.2	**dorsal (thoracic), closed**	**37**	**29**	**8**
806.21	T1-T6 level with complete lesion of cord	11	10	1
806.23	T1-T6 level with central cord syndrome	1	1	
806.24	T1-T6 level with other specified spinal cord injury	4	3	1
806.25	T7-T12 level with unspecified spinal cord injury	8	4	4
806.26	T7-T12 level with complete lesion of cord	7	6	1
806.27	T7-T12 level with anterior cord syndrome	1		1
806.29	T7-T12 level with other specified spinal cord injury	5	5	
806.3	**dorsal (thoracic), open**	**6**	**6**	
806.30	T1-T6 level with unspecified spinal cord injury	1	1	
806.31	T1-T6 level with complete lesion of cord	1	1	
806.34	T1-T6 level with other specified spinal cord injury	1	1	
806.35	T7-T12 level with unspecified spinal cord injury	1	1	
806.36	T7-T12 level with complete lesion of cord	1	1	
806.39	T7-T12 level with other specified spinal cord injury	1	1	
806.4	**lumbar, closed**	**1**	**1**	
806.5	**lumbar, open**	**23**	**17**	**6**
806.6	**sacrum and coccyx, closed**	**2**	**1**	**1**
806.60	With unspecified spinal cord injury	1		1
806.69	With other spinal cord injury	1	1	
952	**SCI without evidence of spinal bone injury**			
952.0	**cervical**	**70**	**62**	**8**
952.00	C1-C4 level with unspecified spinal cord injury	19	16	3
952.01	C1-C4 level with complete lesion of spinal cord	1	1	
952.03	C1-C4 level with central cord syndrome	19	19	
952.04	C1-C4 level with other specified spinal cord injury	8	7	1
952.05	C1-C4 level with unspecified spinal cord injury	8	6	2
952.08	C5-C7 level with central cord syndrome	10	8	2
952.09	C5-C7 level with other specified spinal cord injury	5	5	
952.1	**dorsal (thoracic)**	**9**	**6**	**3**
952.10	T1-T6 level with unspecified spinal cord injury	4	3	1

diagnosis code	principal diagnosis	all	male	female
952.11	T1-T6 level with complete lesion of spinal cord	1	1	
952.14	T1-T6 level with other specified spinal cord injury	2		2
952.15	T7-T12 level with unspecified spinal cord injury	1	1	
952.19	T7-T12 level with other specified spinal cord injury	1	1	
952.2	**lumbar**	**4**	**3**	**1**
952.8	**multiple sites of spinal cord**	**4**	**2**	**2**
952.9	**unspecified site of spinal cord**	**5**	**4**	**1**
totals		**202**	**164**	**38**

*Numbers do not coincide with 1998 incidence because only principal diagnoses are counted here.

e codes
Table 1.4

e code	description	all	male	female
E810.0- E819.9	**motor vehicle accidents - traffic**	**78**	**67**	**11**
812.0	Traffic accident with motor vehicle, driver	18	15	3
812.1	Traffic accident with motor vehicle, passenger	5	3	2
813.0	Traffic accident, collision with other vehicle, driver	2	2	
814.7	Traffic accident, collision with pedestrian, pedestrian	1	1	
815.0	Traffic accident, collision on the highway, driver	2	2	
815.1	Traffic accident, collision on the highway, passenger	1	1	
816.0	Traffic accident, loss of control, driver	28	26	2
816.1	Traffic accident, loss of control, passenger	6	4	2
816.2	Traffic accident, loss of control, motorcyclist	6	6	
818.1	Traffic accident, other, non-collision, passenger	1		1
818.2	Traffic accident, other, non-collision, motorcyclist	1	1	
819.0	Unspecified motor vehicle accident, driver	2	2	
819.1	Unspecified motor vehicle accident, passenger	2	1	1
819.9	Unspecified motor vehicle accident, unspecified person	3	3	
E820.0-E825.9	**motor vehicle accidents – non traffic**	**11**	**11**	
820.0	Non-traffic accident (snow vehicle), driver	2	2	
821.0	Off-road motor vehicle, driver	3	3	
821.2	Off-road motor vehicle, passenger	3	3	
823.0	Collision with moving object, driver	2	2	
825.1	Accident of other and unspecified nature, passenger	1	1	
E826.0-E829.9	**other road vehicle accidents**	**3**	**3**	
826.1	Pedal cycle accident, cyclist	1	1	
828.2	Accident involving animal being ridden, rider	2	2	
E830.0-E838.9	**water transport accidents**	**1**	**1**	
838.8	Other and unspecified accident	1	1	
E840.0-E845.9	**air and space transport accidents**	**2**	**2**	
843.6	Fall in, on, or from aircraft, occupant of unpowered craft	1	1	
844.7	Other specified air transport accidents, parachutist	1	1	
E846.0-E848.9	**other vehicle accidents – nec**	**4**	**2**	**2**
848	Accidents involving vehicles, not elsewhere classified	4	2	2
E849.0-E849.9	**place of occurrence**	**1**	**1**	
849.8	Other specified places	1	1	
E878.0-E879.9	**surgical and medical procedure**	**2**	**2**	
878.4	Other restorative surgery	1	1	
879.8	Other specified procedures	1	1	
E880.0-E888.9	**accidental falls**	**98**	**74**	**24**
880.9	Fall from stairs or steps, other stairs or steps	12	7	5
881.0	Fall from ladder	8	7	1
881.1	Fall from scaffolding	1	1	
882	Fall from or out of building	8	6	2

e code	description	all	male	female
883.0	Accident from diving or jumping into water	5	5	
884.3	Fall from wheelchair	1	1	
884.4	Fall from bed	1		1
884.9	Fall from one level to another	19	18	1
885	Fall from same level, slip, trip, or stumble	17	13	4
886.0	Sports tackle	2	2	
887	Fracture, cause unspecified	2	1	1
888	Other & unspecified fall	22	13	9
E900.0-E909.9	**natural and environmental factors**	**1**	**1**	
906.8	Other specified injury caused by animals	1	1	
E916.0-E928.9	**other accidents**	**29**	**23**	**6**
916	Struck by falling object	5	5	
917.0	Struck by objects or persons – in sports	11	9	2
917.9	Struck by objects or persons – other	5	5	
919.8	Accident caused by machinery	1	1	
922.9	Accident caused by firearm, unspecified firearm	1		1
927	Overexertion and strenuous movements	2	2	
928.9	Unspecified environmental and accidental causes	4	1	3
E929.0-E929.9	**late effects of injury**	**5**	**4**	**1**
929.0	Of motor vehicle accident	1	1	
929.1	Of other transport accident	1	1	
929.3	Late effects of accidental fall	1		1
929.8	Of other accidents	1	1	
929.9	Of unspecified accident	1	1	
E930.0-E949.9	**therapeautic use**	**1**		**1**
935.2	Opiates and related narcotics	1		1
E950.0-E959.9	**suicide and self inflicted**	**1**		**1**
958.5	Crashing of motor vehicle	1		1
E960.0-E969.9	**homicide and intentional injury**	**21**	**15**	**6**
957.1	Suicide/self-inflicted injury, jumping from high place	1		1
960.0	Fight/ brawl/rape, unarmed fight or brawl	2	2	
965.0	Assault by firearms, handgun	2	1	1
965.4	Assault by firearms, other and unspecified firearms	12	11	1
966	Assault by cutting and piercing instrument	3	1	2
968.9	Assault, other, unspecified	1		1
E980.0-E989.9	**undetermined injury**	**1**	**1**	
985.4	Intention unknown accident, other, unspecified firearm	1	1	

appendix 1.2

SCI Data 1998

1998 data
Table 1.5

category of data	total	male	female
incidence			
Incidence (by gender)	259	207 (80%)	52 (20%)
age			
0-17	15	12	3
18-44	144	123	21
45-64	53	43	10
65+	47	29	18
race			
American Indian, Native Alaskan	1		1
Asian, Pacific Islander	1	1	
African American	38	29	9
White	183	147	36
Hispanic	4	2	2
Other	29	25	4
Unspecified	3	3	
admission month			
January	16	13	3
February	14	13	1
March	14	10	4
April	22	20	2
May	26	20	6
June	34	27	7
July	22	17	5
August	17	12	5
September	25	22	3
October	21	14	7
November	26	23	3
December	22	16	6
admission day			
Monday	32	21	11
Tuesday	34	30	4
Wednesday	37	31	6
Thursday	30	23	7
Friday	32	26	6
Saturday	50	41	9
Sunday	44	35	9
admission type			
Emergency	158	127	31
Urgent	76	60	16
Elective	25	20	5

category of data	total	male	female
admission source			
Physician referral	37	28	9
Clinic referral	2	1	1
HMO referral	1	1	
Transfer from hospital	29	24	5
Transfer from another health care facility	9	8	1
Emergency room	177	143	34
Information not available	4	2	2
length of inpatient stay			
Total number of days	5300	4564	736
Average number of days	16.9	17.8	12.9
cost of inpatient hospital data			
Total	$11,095,134.42	$9,087,445.82	$2,007,688.60
Average	$42,838.36	$43,900.70	$38,609.40
causes of injury			
Falls	98	74	24
Motor vehicle accidents – traffic and non traffic	89	78	11
Other injury events	32	26	6
Other transportation injuries	10	8	2
Homicide, intentional injury and intention unknown	23	16	7
Natural/Environmental factors	1	1	
Late effects of injury	5	4	1
Therapeutic Substances	1		1
level of severity			
Tetraplegia	111*	95	16
Paraplegia	91*	69	22
patient discharge location			
Discharged to home or self-care	104	86	18
Discharged or transferred to another short-term general hospital	27	25	2
Discharged or transferred to a skilled nursing facility	19	10	9
Discharged or transferred to an intermediate care facility	24	22	2
Discharged or transferred to another type of institution	59	48	11
Discharged or transferred to Home under care of organized health service	15	8	7
Left against medical advice	1	1	
Expired or did not recover	10	7	3

*Numbers do not coincide with 1998 incidence because only principal diagnoses are counted here.

appendix 1.3

Glossary of Terms
Wisconsin's Population and Incidence of Injury by County
Wisconsin's Population Projections by Age Group

glossary of terms

Central Nervous System (CNS): the brain, spinal cord and retina.

Cervical Spine: highest level in the spine, the neck region, consisting of seven vertebrae and eight nerve roots.

Clinic Referral: the patient was admitted to a facility upon recommendation of a clinic physician.

Coccyx: the tailbone, with one vertebrae and nerve root.

Complete Injury: injury that leaves no motor function or sensation below the spinal cord injury zone.

Elective Admission: an admission that can be delayed without substantial risk to the health of the individual. This means the patient's condition permits adequate time to schedule the availability of a suitable accommodation.

Emergency Admission: the patient requires immediate medical intervention as a result of severe, life threatening or potentially disabling conditions. Usually the patient is admitted through the emergency room.

Emergency Referral: the patient was admitted to a facility upon recommendation of an emergency room physician.

HMO Referral: the patient was referred to a facility upon the recommendation of a health maintenance organization physician.

Incomplete Injury: spinal cord damage leaving some sensation and/or motor control below the injury zone because some nerve pathways remain intact.

Level of Injury: level of injury is determined by which vertebrae of the spinal cord has been injured. The closer the injury is to the brain, the greater the loss of function and feeling will be. C3-T1 will produce tetraplegia. T1 and below will produce paraplegia; C5 and above will produce tetraplegia with reduced respiratory function.

Lumbar Spine: the strongest part of the spine, the lower back, consisting of five vertebrae and nerve roots.

Paraplegia: loss of function below the cervical spinal cord segments, upper body usually retains most function and sensation.

Physician Referral: the patient was admitted to a facility upon the recommendation of his or her physician.

Tetraplegia (formerly quadraplegia): loss of function of any injured or diseased cervical spinal cord segment, affecting all four limbs.

Transfer from Another Health Care Facility: the patient was admitted to a facility as a transfer from a health care facility other than an acute care facility or a skilled nursing facility.

Transfer from a Hospital: the patient was admitted to a facility as a transfer from an acute care facility where he or she was an inpatient.

Transfer from a Skilled Nursing Facility: the patient was admitted to a facility as a transfer from a skilled nursing facility where he or she was and inpatient.

Sacrum Spine: below the lumbar spine, with five vertebrae and nerve roots.

Spinal Cord Injury: any injury of the neural elements within the spinal canal. Can occur from either trauma or disease.

Thoracic Spine: at the level of the chest, has twelve vertebrae and nerve roots.

Urgent Admission: the patient requires immediate attention for the care and treatment of a physical or mental disorder. Generally the patient is admitted to the first available and suitable accommodation.

Ventilator: a mechanical apparatus or machine, which is used for artificially ventilating the lungs.

wisconsin's population and incidence of injury by county

table 1.6

county name	1990 census	1998 census	number of injuries
Adams	15,682	18,000	0
Ashland	16,307	16,770	0
Barron	40,750	42,880	1
Bayfield	14,008	14,660	0
Brown	195,594	219,340	12
Buffalo	13,584	13,830	0
Burnett	13,084	14,080	0
Calumet	34,291	39,240	1
Chippewa	52,360	55,030	9
Clark	31,647	32,770	4
Columbia	45,088	49,520	1
Crawford	15,940	16,770	2
Dane	367,085	409,900	9
Dodge	76,559	83,870	6
Door	25,690	26,650	1
Douglas	41,758	42,250	0
Dunn	35,909	38,490	0
Eau Claire	85,183	91,190	4
Florence	4,590	5,110	0
Fond du Lac	90,083	96,450	5
Forest	8,776	9,350	1
Grant	49,266	49,890	3
Green	30,339	32,120	0
Green Lake	18,651	19,680	0
Iowa	20,150	22,040	0
Iron	6,153	6,340	0
Jackson	16,588	18,410	2
Jefferson	67,783	73,690	4
Juneau	21,650	23,540	0
Kenosha	128,181	142,160	4
Kewaunee	18,878	20,040	3
LaCrosse	97,904	105,760	7
Lafayette	16,074	16,320	0
Langlade	19,505	20,680	1
Lincoln	26,993	28,980	3
Manitowoc	80,421	84,740	3
Marathon	115,400	126,110	3

county name	1990 census	1998 census	number of injuries
Marinette	40,548	42,750	1
Marquette	12,321	13,900	1
Menominee	3,890	4,260	1
Milwaukee	959,275	956,460	74
Monroe	36,633	39,000	3
Oconto	30,226	33,380	4
Oneida	31,679	34,600	2
Outagamie	140,510	157,040	10
Ozaukee	72,831	80,420	0
Pepin	7,107	7,220	0
Pierce	32,765	34,720	0
Polk	34,773	37,200	0
Portage	61,405	67,130	1
Price	15,600	16,330	0
Racine	175,034	187,710	9
Richland	17,521	17,790	1
Rock	139,510	150,320	9
Rusk	15,079	15,330	1
St. Croix	50,251	57,770	0
Sauk	46,975	52,630	2
Sawyer	14,181	15,630	0
Shawano	37,157	38,830	2
Sheboygan	103,877	111,900	6
Taylor	18,901	19,520	1
Trempealeau	25,263	26,390	2
Vernon	25,617	26,570	1
Vilas	17,707	19,530	2
Walworth	75,000	85,170	4
Washburn	13,772	14,910	0
Washington	95,328	113,190	6
Waukesha	304,715	347,460	18
Waupaca	46,104	49,960	1
Waushara	19,385	21,040	0
Winnebago	140,320	154,520	7
Wood	73,605	77,700	1
	4,891,769	**5,255,180***	**259**

*Numbers may not add exactly due to rounding by State demographers.

wisconsin population projections by age group

Table 1.7

age group	1998 population projections
0 - 17	1,356,810
18 – 44	2,087,030
45 – 64	1,116,370
65+	694,970
totals	**5,255,180**

appendix 1.4

Verification Study Abstract

Coding Validity Issues in Spinal Cord Injury

Kimberly Schindler, M.S., C.R.C., Dennis Maiman, M.D., Ph.D.,
Irma Fiedler, Ph.D., Prakash Laud, Ph.D.

Medical College of Wisconsin, Milwaukee, WI
Wisconsin Department of Health and Family Services, Office for People with Physical Disabilities, Madison, WI

ABSTRACT

While analyzing data for the Wisconsin Spinal Cord Injury Registry, questions arose as to the validity of counting all cases with spinal cord injury (SCI) discharge codes (806, 952) as new SCIs. Of interest were those injuries resulting in the permanent neurological deficit necessitating an inpatient rehabilitation stay. A validity screen was developed using the available codes by the Medical College of Wisconsin Model Spinal Cord Injury Center, supported by a grant from the National Institute on disability and Rehabilitation Research (NIDRR). Data were reviewed to determine whether those data critical to the diagnosis of permanent spinal cord injury were accurately profiled. Diagnoses reviewed included acute paraplegia or tetraplegia, bowel and bladder paralysis and systemic problems typically associated with permanent spinal cord injury. Also incorporated in the determination of acuity was the performance of surgery for decompression or stabilization of the spine, placement of a halo, and transfer into a rehabilitation environment. Lengths of stay and outcome data were also considered if there was no evidence of a permanent neurological deficit, i.e. patient demonstrated transient quadriparesis, or was discharged home after one day of inpatient hospital care. To validate this process, fifteen medical records from Froedtert Memorial Lutheran Hospital were blindly reviewed. Eighty-seven percent of the determinations of spinal cord injury with permanent neurological deficit were found to be correct, with one false positive and one false negative. Although a time-consuming process, this type of data review can be used to predict the existence of spinal cord injury from hospital coding data.

INTRODUCTION

Johnson et al. [1] raised the issue of accuracy in reporting of spinal cord injury to a statewide database in Colorado. They report a positive predictive value of 0.55, which implies that one can be only 55 percent certain that an identified case of spinal cord injury resulted in permanent neurological deficit.

The Wisconsin SCI Registry, in conjunction with the Medical College of Wisconsin and Froedtert Memorial Lutheran Hospital sought to address this issue by conducting a sample study of individuals coded by the hospital according to the Center for Disease Control requirements of 806 or 952.

METHODS

Determinations of acuity were based on summarized patient information from the Wisconsin Bureau of Health Information. The summaries included:

- formal definitions of diagnosis codes
- formal definitions of procedure codes
- length of stay
- discharge status
- E-Codes

All individual identifying information was removed and the summaries were evaluated by a neurosurgeon familiar with SCI. The summaries were placed in one of two categories:

- New SCI with permanent neurological deficit
- Not a new SCI with permanent neurological deficit

Fifteen records were selected at random from 1990, 1993 and 1994 data to test the preliminary effectiveness of the summary evaluations. The summary evaluations were compared against patient medical record reviews. One false positive and one false negative were also found.

[1] In the American Journal of Epidemiology, Vol. 146, pp 266-272, 1997.

Preliminary Results

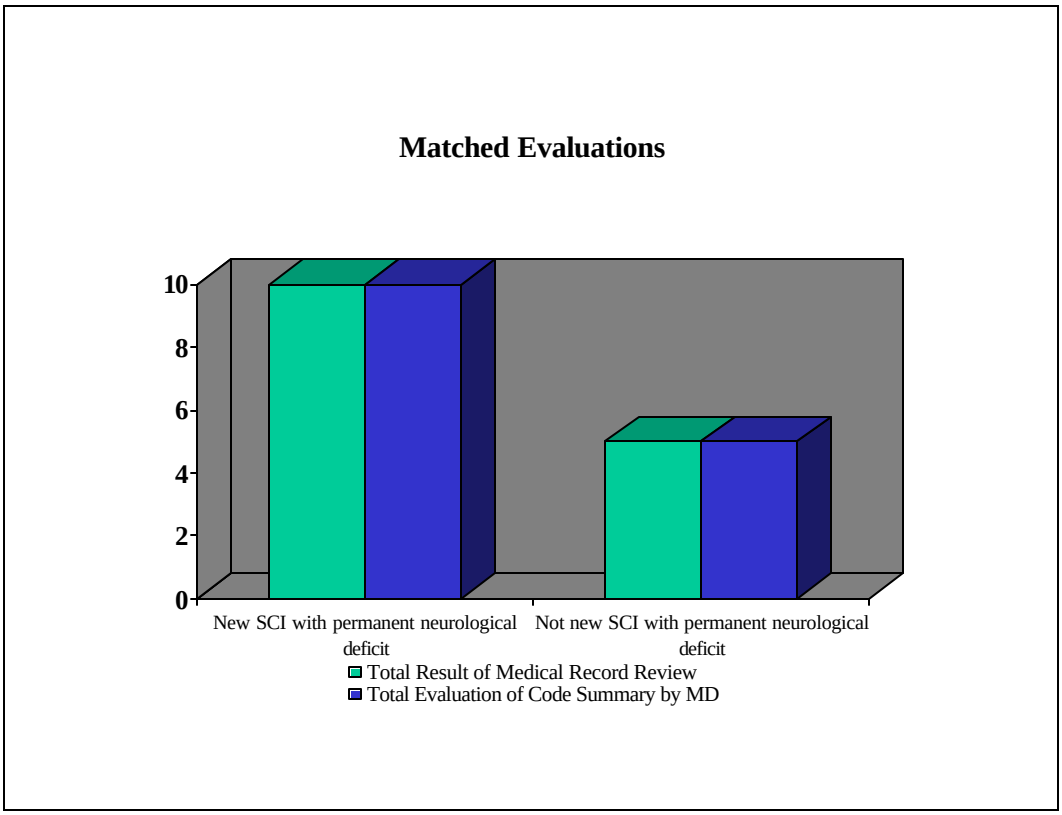
Demographic of Participants (N=15)
Males = 11; Females = 4

Study-assigned ID Number	Evaluation of Code Summary by MD	Result of Medical Record Review	Match?
1	N	N	Yes
2	Y	N	No
3	Y	Y	Yes
4	N	N	Yes
5	N	Y	No
6	Y	Y	Yes
7	Y	Y	Yes
8	Y	Y	Yes
9	N	N	Yes
10	Y	Y	Yes
11	N	N	Yes
12	Y	Y	Yes
13	Y	Y	Yes
14	Y	Y	Yes
15	Y	Y	Yes

N = Not a new SCI with permanent neurological deficit

Y = New SCI with permanent neurological deficit

- Using discharge codes of 806 and 952 as indicators of new SCI resulted in a positive predictive value of 0.667 (10/15)
- Evaluation of summary codes by the MD increased the positive predictive value to 0.90 (9/10)
- The false positive rate of MD evaluation was 0.20 (1/5)
- The fales negative rate of MD evaluation was 0.10 (1/10)
- The overall accuracy of MD evaluation was 87% (13/15)


Matched Evaluations
10
8
6
4
2
0
New SCI with permanent neurological deficit
Not new SCI with permanent neurological deficit
Total Result of Medical Record Review
Total Evaluation of Code Summary by MD

SUMMARY/OBSERVATIONS/CONCLUSIONS

Although the initial process of creating patient diagnosis definition summaries is time consuming, it can be abbreviated by associating macro definitions with the diagnosis codes leading to faster compilation of patient diagnosis definition summaries.

This process is currently being tested on a larger scale in Wisconsin to verify its predictive value. If found to be a valid process, its application to a national audience may provide a method for answering the questions posed by Colorado's registry.