Bladder Cancer Mortality after Spinal Cord Injury over 4 Decades

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Purpose: We estimate bladder cancer mortality in people with spinal cord injury compared to the general population.

Materials and Methods: Data and statistics were retrieved from the National Spinal Cord Injury Statistical Center and the National Center for Health Statistics. The mortality experience of the 45,486 patients with traumatic spinal cord injury treated at a Spinal Cord Injury Model System or Shriners Hospital was compared to the general population using a standardized mortality ratio. The standardized mortality ratio data were further stratified by age, gender, race, time since injury and injury severity.

Results: Our study included 566,532 person-years of followup between 1960 and 2009, identified 10,575 deaths and categorized 99 deaths from bladder cancer. The expected number of deaths from bladder cancer would have been 14.8 if patients with spinal cord injury had the same bladder cancer mortality as the general population. Thus, the standardized mortality ratio is 6.7 (95% CI 5.4–8.1). Increased mortality risk from bladder cancer was observed for various ages, races and genders, as well as for those injured for 10 or more years and with motor complete injuries. Bladder cancer mortality was not significantly increased for ventilator users, those with motor incomplete injuries or those injured less than 10 years.

Conclusions: Individuals with a spinal cord injury can potentially live healthier and longer by reducing the incidence and mortality of bladder cancer. Study findings highlight the need to identify at risk groups and contributing factors for bladder cancer death, leading to the development of prevention, screening and management strategies.

Key Words: spinal cord injuries, urinary bladder neoplasms, mortality

Abbreviations and Acronyms

AIS = American Spinal Injury Association Impairment Scale

NDI = National Death Index

NSCID = National Spinal Cord Injury Database

NSSCID = National Shriners Spinal Cord Injury Database

SCI = spinal cord injury

SCIMS = Spinal Cord Injury Model Systems

SMR = standardized mortality ratio

SSDI = Social Security Death Index

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Study received institutional review board approval.

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Spinal cord injury is associated with significant secondary medical and psychosocial conditions throughout life. Renal failure used to be the leading cause of death among patients with SCI,[1,2] but advances in neurogenic bladder management in the last 5 decades have made genitourinary system diseases a more common cause of morbidity rather than mortality.[2,3] Now cancer ranks among the top 3 causes of death.[2] Bladder cancer specifically is the third leading cause of cancer death in this population, while it is ranked tenth in the general population.[4]

The current estimate of bladder cancer incidence, calculated as the number of new bladder cancer cases identified during the study period

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divided by the total number of SCI cases, is highly variable (0.1% to 10.0%).[5] However, the mortality risk of bladder cancer has not been consistently addressed in the SCI literature. Groah et al calculated a standardized mortality ratio based on 12 bladder cancer deaths in a study of 3,670 patients with SCI, resulting in a 70 times increased mortality risk compared to the general population.[6] However, given the small cohort, this SMR estimate has a wide 95% CI (36.9–123.3), and the estimate was not specifically tailored to individual age, gender and racial groups.

Thus, in this study we provide a better estimate of increased bladder cancer mortality, using a large cohort of 45,486 individuals with traumatic SCI. In addition, we assess whether increased bladder cancer mortality varies by demographic and injury characteristics. Understanding this potentially fatal complication after SCI will guide the direction of future research that targets the prevention, screening and treatment of bladder cancer.

MATERIALS AND METHODS

Data Sources and Study Population

Participants and SCI data for this study were retrieved from 3 data sources. Institutional review board approval was obtained from the National SCI Statistical Center as well as locally at each participating center.

The National SCI Database was established in 1975.[7] Data were collected retrospectively from 1973 and prospectively since 1975. Since its inception 28 federally funded SCIMS throughout the United States have contributed data to the database. To be qualified for the NSCID, patients must have 1) sustained SCI due to a traumatic event, 2) had a clinically discernible degree of neurological deficit and 3) received initial hospital care from one of the SCIMS within 1 year of injury.

To increase sample size and to supplement mortality information contained in the NSCID, a series of collaborative survival studies were conducted during 1973 to 1999,[8] recruiting additional participants from several SCIMS who were not registered in the NSCID. While approximately 92% of participants were injured after 1970, there are participants injured as long ago as 1936 and admitted to the SCIMS as early as 1960.

A parallel NSSCID that enrolls children with SCI who received care from the 3 SCI units of the Shriners Hospital for Children in California, Illinois and Pennsylvania was established in 1987. Data have been collected prospectively since 1987 using the same protocol as the NSCID,[9] except that the NSSCID includes patients admitted to the system beyond 1 year of injury. A total of 45,486 individuals were eligible for this study, including 38,205 from the NSCID, 5,199 from the collaborative survival study and 2,122 from the NSSCID (table 1).

Demographic and Injury Profile

Demographic and injury characteristics were collected by trained personnel during initial hospital care. Neurological examinations were performed in accordance with the International Standards for Neurological Classification of SCI.[10] Ventilator dependency was defined as requiring partial or total respiratory support on a daily basis. For analysis, ventilator-free participants were further grouped into 1 of 4 neurological categories according to the AIS or Frankel's classification scale of 1) high tetraplegia with motor functionally complete injury, AIS/Frankel A, B or C (C1-C4 ABC); 2) low tetraplegia with motor functionally complete injury (C5-C8 ABC); 3) paraplegia with motor functionally complete injury (T1-S3 ABC); and 4) motor

Table 1. *Characteristics of study participants*

	Total Participants		Bladder Ca Deaths	
At baseline				
No. gender (%):				
M	36,195	(79.6)	78	(78.8)
F	9,291	(20.4)	21	(21.2)
No. race (%):				
NonHispanic white	30,498	(67.0)	80	(80.8)
NonHispanic black	8,916	(19.6)	10	(10.1)
Hispanic	4,457	(9.8)	6	(6.1)
Asian	727	(1.6)	0	(0.0)
Native American	399	(0.9)	1	(1.0)
Other	248	(0.5)	0	(0.0)
Unknown	241	(0.5)	2	(2.0)
Mean age at injury (SD)	32.8	(16.8)	29.5	(14.2)
No. age at injury (%):				
0–29	24,321	(53.5)	62	(62.6)
30–59	17,043	(37.5)	31	(31.3)
60 or Greater	4,122	(9.1)	6	(6.1)
No. calendar yr of injury (%):				
1936–1970	327	(0.7)	9	(9.1)
1971–1980	8,275	(18.2)	66	(66.7)
1981–1990	12,756	(28.0)	21	(21.2)
1991–2000	14,086	(31.0)	2	(2.0)
2001–2009	10,042	(22.1)	1	(1.0)
No. injury severity (%):				
Ventilator dependent	1,096	(2.4)	0	(0.0)
C1–C4, AIS ABC	5,403	(11.9)	7	(7.1)
C5–C8, AIS ABC	9,360	(20.6)	32	(32.3)
T1–S3, AIS ABC	14,968	(32.9)	49	(49.5)
All levels, AIS D	10,379	(22.8)	8	(8.1)
Unknown	4,280	(9.4)	3	(3.0)
At last followup deceased or withdrew alive				
Mean age (SD)	44.5	(16.7)	52.5	(12.3)
No. current age (%):				
0–29	9,662	(21.2)	1	(1.0)
30–59	27,475	(60.4)	71	(71.7)
60 or Greater	8,349	(18.4)	27	(27.3)
Mean yrs since injury (SD)	12.7	(10.4)	23.9	(8.5)
No. yrs since injury (%):				
Less than 1	8,040	(17.7)	0	(0.0)
1–9	12,941	(28.5)	7	(7.1)
10–19	12,216	(26.9)	18	(18.2)
20 or Greater	12,289	(27.0)	74	(74.7)
No. calendar yr (%):				
1973–1980	743	(1.6)	1	(1.0)
1981–1990	4,593	(10.1)	7	(7.1)
1991–2000	6,418	(14.1)	37	(37.4)
2001–2009	33,732	(73.2)	54	(54.5)
No. bladder management (Form I participants only) (%):*				
Normal	5,814	(25.8)	3	(7.1)
Catheter-free	3,196	(14.2)	13	(31.0)
Intermittent catheterization	6,336	(28.1)	6	(14.3)
Indwelling/suprapubic catheterization	5,802	(25.8)	18	(42.9)
Other	1,378	(6.1)	2	(4.7)

* Data on 22,526 participants and 42 deaths from bladder cancer.