

Table 3: Survival of spinal cord injury (one-year and ten-year mortality) by Region and Author(s) of published data

Region	Country	Author(s) of published data	Observation period	Survival		Comments
				1-year mortality	10-year mortality	
Asia, East						
	Taiwan	Yeh ¹	1977-1989	5.8% (n=94)	n/r*	Of those who died, 26.5% had complete lesions in the cervical region and 3.4% were incomplete. 3% had complete paraplegia and 1.5% were incomplete.
	Taiwan (Hualien County)	Lan ²	1986-1990	10.1% (n=10)	n/r	Nine cases were tetraplegic, 6 of these died from respiratory failure during acute care. The paraplegic patient died 8 months post injury from pressure sore- related septicaemia.
Asia, South						
	Pakistan	Masood ³	2003-2007	10.7% (n=23)	n/r	Died during hospitalisation.
Asia, Southeast						
	Thailand (Chiang Mai)	Kovindha ⁴	1985-1991	8% (n=31)	n/r	Four of the cases who died were high tetraplegics who refused treatment. 23 cases died during acute stage and 4 cases after 6 weeks of admission.
	Thailand (Bangkok)	Parajareya ⁵	1989-1994	16% (n=35 died in acute care hospital)	n/r	Respiratory complications accounted for 89% of total deaths (n=219). 68% of the deaths had complete cervical injury.
Australasia						
	Australia	O'Connor ⁶	1986-1998	5.7%	14.3%	110 deaths occurred in the first two months.
	Australia (NSW)	Soden ⁷	1955-1994	n/r	SMR 2.3	Total of 195 deaths, expected 85 deaths. Study cohort was 335 individuals with SCI who had died. Leading causes of death were pneumonia and influenza (n=27) and septicaemia (n=25).

continued

Table 3 (continued): Survival of spinal cord injury (one-year and ten-year mortality) by Region and Author(s) of published data

Region	Country	Author(s) of published data	Observation period	Survival		Comments
				1-year mortality	10-year mortality	
	Australia (NSW)	Yeo ⁸	1955-1994	n/r	9% (n=132 died within 18 months; 12% with tetraplegia and 5% with paraplegia)	Total 1,453 SCI patients, 55% with cervical lesions and 45% with thoracic/lumbar lesions. A further 14% (n=197 died after 18 months; 60% of these deaths occurred in people with cervical lesions and 40% with thoracic/lumbar lesions.
	Australia (Victoria)	Cheshire ⁹	1959-1966	6.1% (n=20)	6.1% (n=20)	Acute deaths from SCI <60 days; chronic deaths from SCI > 60 days post accident. Acute respiratory deaths were responsible for 70% of the SCI deaths.
Europe, Western						
	Denmark	Hartkopp ¹⁰	1953-1971 and 1972-1990	n/r	14.5% (n=52 out of a total of 359; SCI at first inclusion period, dead at 1973): 16.4% (n=87 out of a total of 529; SCI at second inclusion period, dead at 1992)	Most common causes of death was lung disease, such as pneumonia, suicide and ischaemic heart disease. Among tetraplegic individuals, 76% of deaths were caused by lung disease and pneumonia.
	Israel	Zeilig ¹¹	1948		50% (n=10) died 50 years later, average age at death was 60 years.	Participants (20: 19 males, 1 female) with SCI that occurred during the 1948 Israel War of Independence. No regular follow-up during the first 20 years post injury. Mean age at injury was 22.6 years. No individuals with complete tetraplegia. There were 13 paraplegia ASIA A cases, 4 paraplegia ASIA C-D and one tetraplegia ASIA C.

continued

Table 3 (continued): Survival of spinal cord injury (one-year and ten-year mortality) by Region and Author(s) of published data

Region	Country	Author(s) of published data	Observation period	Survival		Comments
				1-year mortality	10-year mortality	
	Israel	Tchvaloon ¹²	1962-2004		7.1% (n=10)	143 SCI patients following road accidents. Age at injury 37.8 years (mean). 43% were cervical, 49.3% thoracic and 7.7% lumbar. 41% were complete at admission to rehabilitation (Frankel grade A). Maximum survival was 43.3 years after injury.
	Italy	Pagliacci ¹³	1997-1999		16% (n=82) after post-discharge; mean time of 3.8 years. 7% (n=36) had died prior to the survey.	511 persons out of 608 first-admission SCI patients who were discharged between 1997-1999 from 7 spinal units and 17 rehabilitation units were located and surveyed.
	Norway	Lidal ¹⁴	1961-1982	n/r	36.7% (n=142)	142 of 387 patients with traumatic SCI died during the observation period. The main causes of death were pneumonia/influenza (16%), ischaemic heart diseases (13%) and urogenital diseases (13%). Main risk factors for higher deaths were: higher age at injury, tetraplegia and functionally complete SCI.
	Portugal (Coimbra)	Martins ¹⁵	1989-1992	56% (n=223)	n/r	398 new cases of SCI were identified for the period 1998-1992. Of these, 64 (16%) were dead on arrival at hospital, 159 (40%) died during acute care, and 13 died after several months.
Latin America, Tropical	Brazil	Brasil ¹⁶	1986-1995	10.9% (n=18)	n/r	164 patients with traumatic SCI. Of these 18 died (15/100 cervical SCI, 2/27 thoracic and 1/37 thoraco-lumbar). Highest death rate was in the cervical complete cases.

continued

Table 3 (continued): Survival of spinal cord injury (one-year and ten-year mortality) by Region and Author(s) of published data

Region	Country	Author(s) of published data	Observation period	Survival		Comments
				1-year mortality	10-year mortality	
North America, High Income	Brazil	Neumann ¹⁷	2001-2005	26.2% died during acute care.		84 patients with cervical SCI. 26% of patients with complete cervical lesion (n=28) died in hospital. Number dropped to 5.2% when cases with significant brain injury or haemodynamic instability were excluded.
	Brazil (San Paulo)	Barros ¹⁸	1982-1987	21% (n=90)		In hospital deaths, mostly by respiratory failure
	Canada (Toronto)	Kattail ¹⁹	1996-2007	4% (Note: included 272 cases with no spinal cord lesion)	n/r*	569 patients (mean age of 50 years) with acute spinal trauma. This included 268 cases with ASIA E and 4 Unknown ASIA.
	Canada (Alberta)	Hamilton ²⁰	1975-1988	n/r	3% (n=6)	Of the 174 paediatric cases, 6 died (5 had complete cord injuries).
	Canada (Manitoba)	Hu ²¹	1981-1984	n/r*	10.7% (n=13)	Retrospective cross-sectional study of 122 patients with neurological injury. Mortality increased with increasing age at injury.
	USA	Shavelle ²²	1973-2003	61% (n=491)	n/r	Study group: 810 persons injured at 20 years of age and older who were ventilator dependent at discharge from rehabilitation. 319 persons survived the first year. Of the group where cause of death was known (69%), 31% of deaths were caused by pneumonia and other respiratory diseases.
	USA	Samsa ²³	1940-1987	n/r	15%	Population of veterans with traumatic SCI (n=13,519)

continued

Table 3 (continued): Survival of spinal cord injury (one-year and ten-year mortality) by Region and Author(s) of published data

Region	Country	Author(s) of published data	Observation period	Survival		Comments
				1-year mortality	10-year mortality	
	USA	Burney ²⁴	1982-1989	17% (Acute care deaths due to SCI with other injuries); 6.9% (Acute deaths with only SCI)	n/r	Based on 2,946 patients entered in the Major Trauma Outcome Study (MTOS) database
	USA	Stover ²⁵	1984	n/r	14%	Based on entire National Database (approx. 10,000 plus cases). Incomplete paraplegics have the highest survival rate, followed by complete paraplegics, incomplete tetraplegics and complete tetraplegics. Leading causes of death were pneumonia, septicaemia and pulmonary emboli.
	USA (California)	Kraus ²⁶	1970-1971	48.3% (n=299 out of 619 cases)	n/r	Deaths occurred during the period from injury date to hospital discharge. 79% of the cases were dead on arrival, the remaining 21.4% died on ward.
	USA (California)	Kraus ²⁷	1970-1971	n/r	53.9%	Five to six-years after SCI, 35 out of 320 (or a total of 334 persons died out of 619 cases) persons had died. Cause of death in the 35 cases was primarily due to cardio-respiratory or renal complications.
	USA (Maryland)	Bohlman ²⁸	1950-1972	37% (n=67)	n/r	180 patients with cervical level SCI, 113 survived for at least one year. 86 of these patients had follow up for 2 to 16 years.
	USA (Oklahoma)	Price ²⁹	1988-1990	8% (n=30)	n/r	376 persons were hospitalised with SCI. Of these, 30 died during hospitalisation and rehabilitation.
	USA (California)	Krause ³⁰	1996	n/r	16% (n=52)	278 people out of 330 with SCI in 1985 were alive in 1996.

continued

Table 3 (continued): Survival of spinal cord injury (one-year and ten-year mortality) by Region and Author(s) of published data

Region	Country	Author(s) of published data	Observation period	Survival		Comments
				1-year mortality	10-year mortality	
	USA (Southeast)	Krause ³¹	1997-1998		14.8% (n=179)	Participants: 1,209, mean age at injury was 32 years, with average of 9 years since their injury. 54% had cervical injuries.
	USA (Southeast)	Krause ³²	1997-2005	n/r	16.2% (n=225)	Participants: 1389 adults with traumatic SCI occurring at least 1 year prior to the study in late 1997 and early 1998
Sub-Saharan Africa, Southern	Zimbabwe	Levy ³³	1988-1994	49% (n=67)	n/r	136 people with traumatic SCI were sent to rehabilitation centres. Ten died in the rehabilitation centre from septicaemia due to pressure sores. Two-thirds who died were tetraplegics. A further 57 had died before one year. Two-thirds who died were tetraplegic.
	South Africa (Cape Province)	Key ³⁴	1963-1967	13% (38 out of 300 SCI cases died in hospital)	n/r	63% who died while in hospital were tetraplegics. Another 3% (n=9) died after discharge primarily from bed sores (septicaemia) and pneumonia.
Sub-Saharan Africa, West	Nigeria (Zaria)	Iwegbu ³⁵	1973-1982	25% (n=12)	n/r	25% of 48 patients died within 10 weeks of admission. Of 6 admitted tetraplegia cases, only one survived. 10 of the 12 who died had bed sores at time of death. All had urinary infections.

continued

Table 3 (continued): Survival of spinal cord injury (one-year and ten-year mortality) by Region and Author(s) of published data

Region	Country	Author(s) of published data	Observation period	Survival		Comments
				1-year mortality	10-year mortality	
	Nigeria	Nwuga ³⁶	1974-1977	84% (n=64)	n/r	12 people out of 76 SCI cases survived. C4-C8: 28.2 (Mean number of days survival post discharge) T1-T6: 62.7 (Mean number of days survival post discharge) T7-T12: 68.9 (Mean number of days survival post discharge) L1-S5: 190.7 (Mean number of days survival post discharge)
	Nigeria (Plateau State)	Igun ³⁷	1984-1997	26% (n=18)	n/r	68 cases were treated for SCI. At 30 days post injury, 18 people had died; 67% had cervical injuries and 33% had thoraco-lumbar injuries. A total of 5 patients died from thromboembolic disease, two from acute ascending cord oedema in tetraplegic patients and 11 from seticaemia from bed sores.
	Nigeria (Ilorin)	Solagberu ³⁸	1995-1999	26% (n=10 out of 39 patients)	n/r	Of those who died, 70% had cervical SCI. All died within 12 days.
	Nigeria (Enugu)	Nwankwo ³⁹	1996-2000	11% (n=8 out of 74 patients)	n/r	All were complete tetraplegics, died of respiratory insufficiency within one week of admission.
	Nigeria (Enugu)	Nwadinigwe ⁴⁰	1996-2001	34.3% (n=36 out of 104 patients)	n/r	Of those who died, 89% had cervical spinal injury and died mainly from respiratory failure.
	Sierra Leone	Gosselin ⁴¹	2002-2004	29% (n=7 out of 24 patients died in hospital)	83%	24 patients were admitted with SCI. 7 died while in hospital and a further 13 died after 10 to 28 months after discharge (4 out of 24 patients were lost to follow-up).

* Not reported

** Source/: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, /World Population Prospects: The 2008 Revision/, <http://esa.un.org/unpp>

1. Yeh Y-S, Lee S-T, Liui T-N, Fairholm DJ, Chen W-J, Wong M-K. Features of Spinal Cord Injury in Taiwan (1977-1989). *Chang Gung Med J* 1993; **16**(3): 170-175.
2. Lan C, Lai JS, Chang KH, Jean YC, Lien IN. Traumatic spinal cord injuries in the rural region of Taiwan: an epidemiological study in Haulien county, 1986-1990. *Paraplegia* 1993; **31**: 398-403.
3. Masood Z, Wardug GM, ashraf J. Spinal Injuries: Experience of a local neurosurgical centre. *Pak J Med Sci* 2008; **24**(3): 368-371.
4. Kovindha A. A retrospective study of spinal cord injuries at Maharaj Nakorn Chiang Mai Hospital, during 1985-1991. *Chiang Mai Med Bull* 1993; **32**(2): 85-92.
5. Pajareya K. Traumatic spinal cord injuries in Thailand; an epidemiologic study in Siriraj Hospital, 1989-1994. *Spinal Cord* 1996; **34**: 608-610.
6. O'Connor PJ. Survival after spinal cord injury in Australia. *Arch Phys Med Rehabil* 2005; **86**(1): 37-47.
7. Soden RJ, walsh J, Middleton JW, Craven ML, Rutkowski SB, Yeo JD. Causes of death after spinal cord injury. *Spinal Cord* 2000; **38**: 604-610.
8. Yeo JD, Walsh J, Rutkowski SB, Soden RJ, Craven ML, Middleton JW. Mortality following spinal cord injury. *Spinal Cord* 1998; **36**: 329-336.
9. Cheshire DJE. *The Complete and Centralized Treatment of Paraplegia: A Report on the Spinal Injuries Centre for Victoria, Australia*. National Institute for Neurological Diseases Workshop: Melbourne, Victoria, 1966.
10. Hartkopp A, Bronnum-Hansen H, Seidenschnur A-M, Biering-Sorensen F. Survival and cause of death after traumatic spinal cord injury: A long-term epidemiological survey from Denmark. *Spinal Cord* 1997; **35**: 76-85.
11. Zeilig G, Dolev M, Weingarden H, Blumen N, Shemesh Y, Ohry A. Long-term morbidity and mortality after spinal cord injury: 50 years of follow-up. *Spinal Cord* 2000; **38**: 563-566.
12. Tchvaloon E, Front L, Gelernter I, Ronen J, Bluvshstein V, Catz A. Survival, neurological recovery and morbidity after spinal cord injuries following road accidents in Israel. *Spinal Cord* 2008; **46**(2): 145-149.
13. Pagliacci MC, Franceschini M, Di Clemente B, Agosti M, Spizzichino L. A multicentre follow-up of clinical aspects of traumatic spinal cord injury. *Spinal Cord* 2007; **45**(6): 404-410.
14. Lidal IB, Snekkevik H, Aamodt G, Hjeltnes N, Stanghelle JK, Biering-Sorensen F. Mortality after Spinal Cord Injury in Norway. *J Rehabil Med* 2007; **39**: 145-151.

15. Martins F, Freitas F, Martins L, Dartigues J, Barat M. Spinal cord injuries--epidemiology in Portugal's central region. *Spinal Cord* 1998; **36**(8): 574-578.
16. Brasil AVB, Coelho DG. The neurological outcome of acute spinal cord injury in a neurosurgical hospital of a developing country. *Spinal Cord* 1998; **36**: 353-356.
17. Neumann CR, Brasil AV, Albers F. Risk Factors for Mortality in Traumatic Cervical Spinal Cord Injury: Brazilian Data. *The Journal of Trauma Injury, Infection, and Critical Care* 2009; **67**(1): 67-70.
18. Barros F, Taricco MA, Oliveira RP, Greve JM, Santos LC, Napoli MM. Epidemiological study of patients with spinal cord injuries. *Rev hosp Fac Med S Paulo* 1990; **45**(3): 123-126.
19. Kattail D, Furlan J, Fehlings MG. Epidemiology and Clinical Outcomes of Acute Spine Trauma and Spinal Cord Injury: Experience From a Specialized Spine Trauma Center in Canada in Comparison With a Large National Registry. *The Journal of Trauma Injury, Infection, and Critical Care* 2009; **67**(5): 936-943.
20. Hamilton mG, Myles ST. Pediatric spinal injury: review of 174 hospital admissions. *J. Neurosurg* 1992; **77**: 700-704.
21. Hu R, Mustard CA, Burns C. Epidemiology of incident spinal fracture in a complete population. *Spine* 1996; **21**(4): 492-499.
22. Shavelle RM, DeVivo MJ, Strauss DJ, Paculdo DR, Lammertse DP, Day SM. Long-term Survival of Persons Ventilator Dependent After Spinal Cord Injury. *J Spinal Cord Med* 2006; **29**(5): 511-519.
23. Samsa GP, Patrick CH, Feussner jR. Long-term Survival of Veterens with Traumatic Spinal Cord Injury. *Arch Neurol* 1993; **50**: 909-914.
24. Burney RE, Maio RF, Maynard F, Karunas RB. Incidence, characteristics, and outcome of spinal cord injury at trauma ceners in North America. *Arch Surg* 1992; **128**: 596-599.
25. Stover SL, Fine PR. The epidemology and economics of spinal cord injury. *Paraplegia* 1987; **25**: 225-228.
26. Kraus JF, Franti CE, Riggins RS, Richards D, Borhani NO. Incidence of Traumatic spinal Cord Lesions. *J Chron Dis* 1975; **28**: 471-492.
27. Kraus JF, Franti CE, Borhani NO, Riggins RS. Survival with an Acute Spinal Cord Injury. *J Chron Dis* 1979; **32**: 269-283.
28. Bohlman HH. Acute fractures and Dislocations of the Cervical Spine. *The Journal of Bone and Joint Surgery* 1979; **61-A**(8): 1119-1142.
29. Price C, Makintubee S, Herndon W, Istre GR. Epidemiology of Traumatic Spinal Cord Injury and Acute Hospitalization and Rehabilitation Charges for Spinal Cord

- Injuries in Oklahhoma, 1988-1990. *American Journal of Epidemiology* 1994; **139**(1): 37-47.
30. Kraus JF, Sternberg M, Lottes s, Maides J. Mortality after spinal cord injury: An 11-year prospective study. *Arch Phys Med Rehabil* 1997; **78**(August): 815-821.
 31. Krause JS, Zhai Y, Saunders LL, Carter RE. Risk of mortality after spinal cord injury: An 8-year prospective study. *Arc Phys Med Rehabil* 2009; **90**(October): 1708-1715.
 32. Kraus JF, Carter RE, Pickelsimer EE, Wilson D. A Prospective Study of Health and Risk of Mortality after Spinal Cord Injury. *Arch Phys Med Rehabil* 2008; **89**(August): 1482-1491.
 33. Levy LF, Makarawo S, Madzivire D, Bhebhe E, Verbeek N, Parry O. Problems, struggles and some success with spinal cord injury in Zimbabwe. *Spinal Cord* 1998; **36**: 213-218.
 34. Key AG, Retief PjM. Spinal Cord Injuries: An Analysis of 300 New Lesions. In: *International Medical Society of Paraplegia: Annual Scientific Meeting*. Tel-Aviv: Paraplegia, 1968. pp 243-249.
 35. Iwegbu CG. traumatic paraplegia in Zaria, Nigeria: The case for a centre for injuries of the spine. *Paraplegia* 1983; **21**: 81-85.
 36. Nwuga VCB. A Follow-up Study of Paraplegics and Tetraplegics Discharged from Hospital. *J Trop Med Hyg* 1979; **82**: 30-33.
 37. Igun GO, Obekpa OP, Ugwu BT, Nwadiaro HC. Spinal injuries in the Plateau State, Nigeria. *East African Medical Journal* 1999; **76**(2): 75-79.
 38. Solagberu BA. Spinal cord injuries in Ilorin, Nigeria. *West Afr J Med* 2002; **21**(3): 230-232.
 39. Nwankwo OE, Katchy AU. Outcome of a 12-week programme for management of the spinal cord injured with participation of patient's relations at Hilltop Orthopaedic Hospital, Enugu, Nigeria. *Spinal Cord* 2003; **41**(2): 129-133.
 40. Nwadinigwe CU, Iloabuchi TC, Nwabude IA. Traumatic Spinal Cord Injuries (SCI): A Study of 104 Cases. *Nigerian Journal of Medicine* 2004; **13**(2): 161-165.
 41. Gosselin RA, Coppotelli C. A follow-up study of patients with spinal cord injury in Sierra Leone. *international Orthopaedics (SICOT)* 2005; **29**: 330-332.