LONG TERM LIFE EXPECTANCY IN SPINAL CORD INJURY (SCI) IMPLICATIONS FOR THE UNDERWRITING OF SUBSTANDARD ANNUITIES

LEONARDO CHAIT, MD
Clinical Associate Professor of Medicine
UCLA

Chief Medical Director
Executive Life Insurance Company.
Los Angeles, CA

CONAL WILMOT, MD
Chairman
Department of Physical Medicine and Rehabilitation
Santa Clara Valley Medical Center
San Jose, CA

Clinical Associate Professor
Division of Plastic Surgery
Section of Rehabilitation Medicine
Stanford University School of Medicine.

This subject was initially reviewed by Dr. Chait at the Panel Discussion on Substandard Annuities, ALIMDA Meeting September 27, 1989, Seattle. Dr. Chait then requested Dr. Wilmot's collaboration and criticism which were highly valuable and resulted in this paper.

In the U.S., the incidence of spinal cord injury is 30 cases per million population per year. 55% of spinal cord victims are in the 16 to 30 age group. There is a 4:1 predominance of males over females. Almost 50% are caused by motor vehicle injuries, mainly automobile crashes.

Data on neurologic level of injury refer to the most caudal segment of the spinal cord left with normal motor, sensory and reflex function.

In the lower thoracic and lumbar areas the discrepancy between the bony and neurologic levels of injury is due to the fact that the spinal nerves descend inside the spinal canal before emerging between the vertebrae.

Quadriplegia is caused by lesions affecting any of the 8 cervical segments of the spinal cord. Lesions affecting the thoracic, lumbar or sacral regions of the cord or the cauda equina, cause paraplegia.

The literature shows tremendous disparity in the estimation of life expectancy for SCI if considered as a homogeneous entity. There are many factors that contribute to this discrepancy.

Spinal cord injuries do not constitute a homogeneous entity. Assuming a similar level of care, life expectancy is determined by the level (quadriplegia vs paraplegia), and severity (complete vs incomplete) of the lesion as determined by neurologic examination.

Studies may begin at the time of injury, after in-hospital stabilization, or, as is more applicable to the population that we insure, after transfer to rehabilitation facilities or one year after injury. This eliminates the early mortality period to which we are not usually exposed in these annuity applicants.

Since life expectancy has improved in recent years, those injured within the last 5 to 10 years should have better life expectancies than estimated by older long-term prospective studies. The shorter-term series are weighted towards patients whose follow-up is less than 5 years. This tends to further improve the survival figures.

Prospective studies are done at specialized centers where care is superior to that of community hospitals that treat an equal or greater number of patients. This allows for a bias tending to overestimate life expectancy. It is also likely that sicker patients gravitate towards the specialized centers creating an opposite bias. It is clear that the research uncertainties named by Bacon as "idols"[2] are still alive and well after 370 years.

Expert opinions expressed in the discussion of individual files, show marked discrepancies in cases that appear clinically similar. A good example was provided by a well known neurosurgeon/university professor who reported without trepidation that a quadriplegic patient on whom he was consulted had only a 10% reduction in life expectancy. Rather surprised, one of the authors called him and asked for the basis of his estimate. He answered that " a spinal cord injury patient who survives the first year has a life expectancy within 10% of the normal population." His statement may have been correct but he was lumping together paraplegics and quadriplegics with complete and incomplete lesions and applying the figure to a complete quadriplegic.

Several authors point out that patients injured over age 40 do worse than younger patients.

Most authors classify their patients using a modification of the Frankel Grading System[3] which describes the neurological level below which there is loss of motor and or sensory function. It encompasses the following functional categories:

Modified Frankel Grading System

A. **Complete:** Complete loss of both motor and sensory function.

B. **Incomplete-Preserved sensation only:** Preservation of any demonstrable sensation, excluding subject phantom sensations. Voluntary motor function is absent.

C. **Incomplete-Preserved Motor (non functional):** Preservation of voluntary motor function which performs no useful purpose except psychologically. Sensory function may or may not be preserved.

D. **Incomplete-Preserved Motor (functional):** Preservation of voluntary motor function which is useful functionally.

E. **Recovery:** Complete return of all motor and sensory function. May still have abnormal reflexes.

As "spinal shock" subsides immediately after an injury, it is not unusual to see mild improvement in the degree of incompleteness but it is extremely unusual to see a change in the level of neurological injury or from complete to incomplete quadriplegia. Incomplete paraplegia has the widest dysfunctional range (from negligible to very incapacitating).

In insurance medicine we do not need to discriminate between different types of incomplete lesions; it is enough to classify the spinal cord injuries as complete or incomplete. This is not always easy for non-neurologists. Close attention should be paid to the level of the lesion because partially preserved function in the upper extremities may be due to functioning muscles innervated above the lesion.

For example, a C6 complete quadriplegic, has use of his wrists, and can be independent in grooming, bathing, driving and preparing a simple meal. Attending physicians often label these individuals "incomplete quadriplegics".

High cervical (C1-C4) spinal cord injury. ("High quad.")

This is a devastating disability with total paralysis of the trunk and all four extremities and impairment of respiration. The injured becomes completely dependent upon others for his existence. The survival of these persons is a relatively new event. This new entity should be separated from the general SCI population. High quadriplegia is defined as injury to the spinal cord with the lowest preserved (normal) level at C4 or above. Young and Harris[5] reviewed the National Spinal Cord Injury Data Bank experience in 1982. A preponderance of the "high quad" population has C4 level injuries and retains some diaphragmatic function. Those affected at the C1-C3 levels are entirely respirator dependent. The early mortality is extremely high; 23% of patients hospitalized within the first 24 hours of injury die within 120 days. Only 3% of cases classified as C4 on admission need ventilation aid at discharge.

Stover et al[1] state that complete quadriplegics with very high level injuries (C-1, C-2, or C-3), have a very high mortality.

Diaphragm pacing achieves independence from the ventilator but overall has not made a marked impact on survival.[11,12]

Dr. Joel Rosen, Med. Dir. of the Pacific Region Spinal injury Care System and specialist in Rehabilitation Medicine, stated on a 1983 consultation:

"The matter of life expectancy on a respiratory dependent quadriplegic is at this time unknown. It has only been within the last 5 to 10 years that the number of patients with this problem has grown sufficiently that it has finally been recognized as a major problem". Wilmot[13] has a patient with a 15 year survival and is aware of isolated cases with reported survivals of up to 20 years.[13]

Other consultants quote a two decade survival for the "higher level quadriplegics." But not all of these are respirator-dependent.

The studies that appear to be most applicable to our industry were done in Canada with the participation of Dr. Breithaupt, Medical Director of Manufacturer's Life and collaboration of the companies' Actuarial Department.[4] The Canadian studies are well documented, use sound methodology and have excellent follow-up. The authors excluded all deaths within 1 year of trauma as well as all patients that recovered bladder control. This is the fourth study of a group followed since 1945. The 1983 paper reviewed mortality and causes of death throughout the years. The authors compared 1478 persons studied between 12/1/73 and 12/31/80 with previous cohorts. The main causes of death were cardiovascular, renal, respiratory, suicide and neoplastic. Compared with the 1973 study, there was a marked decrease in deaths due to renal disease. Deaths due to suicide, liver disease and alcohol abuse have increased as compared spinal cord injury patients studied during earlier periods. The relative mortality rate was estimated at 186% for incomplete paraplegics, 209% for incomplete quadriplegics, 318% for complete paraplegics and 767% for complete quadriplegics. The Actuarial Department of Manufacturers Life applied these mortality rates to 1975–77 Province of Ontario Mortality Rate Tables and calculated life expectancies at various ages. The figures showed an improved life expectancy for all categories as compared with the groups that the authors had followed in previous years. However, there was extra mortality in all durations and it persisted well beyond 16 years. Life expectancy was significantly shorter than in the average non-spinal cord injured population.

Other researchers have stated that life expectancy in patients that survive the initial acute period, especially if they are young, is better than the figures published by the Canadian authors.

Young, coauthor of[5], stated[6] that "there is great variability among cases dependent on such factors as age at injury, level of injury, completeness of injury, race, sex and psychosocial considerations."

Although DeVivo et al[7], were mainly interested in assessing the prevalence of SCI, they recognized the *"recurrent conflict present in the literature in the area of life expectancy."* Using information from the literature, especially the Canadian studies, the authors calculated life expectancy at time of injury for various ages. The Tables were weighted for sex, level and extent of lesion.

DeVivo et al pointed out that since life expectancy has improved in recent years, those injured today should have better life expectancies than the most recent long-term prospective studies would indicate.

Young[6] commented that DeVivo's paper was based on the Canadian long-term follow-up studies which included cases originally treated in the late 1940's, 1950's and 1960's. Young believes that DeVivo's estimates are too pessimistic and estimates that complete quadriplegics have a 30 to 50% reduction in life expectancy; complete paraplegics and incomplete quadriplegics between 20 and 40% and incomplete paraplegics from 5 to 20%.

Stover,Fine et al[1], have published an extensive review of patients followed for up to 12 years after the date of injury. Their database is nearly 50% larger than the one upon which Young's work was based. The authors state that "recent studies (including a pilot study conducted at the Univ. of Alabama at Birmingham suggest that "life expectancy for SCI has improved significantly and is probably as high as 30 to 40 years, . . .those who survive the initial few months following injury have relatively low excess mortality when compared with the non-spinal cord injured population." In support of these assertion, the authors quote a 30 year old paper by Burke et al[8], and a recent paper by Mesard et al[9] who followed 2323 white men for 10 years and reported a high mortality only during the first year, afterwards it became much closer to the expected mortality in the general population.

Minaire et al[10] followed 783 patients with traumatic cord le*sions 80% of which had occurred less than 6 months before admission. Seventy percent were paraplegics and 30% quadriplegics. A few patients had a follow-up of more than 10 years, others barely one year. The authors did not discriminate between complete and incomplete lesions. The excellent results were attributed to the relatively short follow-up and improved treatment. After the first year the mortality rate was almost the same as the rest of the population. Three patients committed suicide, an important cause of death as also pointed out by Geisler et al.[4] Two patients had a higher survival time than their theoretical life expectancy.

According to Wilmot[13], the most common cause of death, in patients now undergoing long term follow-up is cardiopulmonary and the second is suicide. Alcohol is common and responsible for many accidents.

Conclusions

Most investigators believe that life expectancy of SCI patients has increased substantially over the past decade but are not able to accurately quantify this change because the cohort, by definition, has too short a follow-up period. Under these circumstances we should be extremely cautious on prognosticating the life expectancy of spinal cord injury patients.

REFERENCES AND SOURCES OF INFORMATION

Spinal cord research foundation (Paralyzed veterans of America) 801 18th St, NW Washington, D.C. 20006. 202-USA-1300 (Source of some references.)

1. Spinal Cord Injury. the Facts and Figures. Stover SL, Fine PR et al. 1986; The Univ. of Alabama at Birmingham, Birmingham, Alabama.
2. Bacon F. Novum Organum. 1620; Great Books, Encyc. Britannica, 21st printing, 1977, 108.
3. Frankel H., Hancock D., Hyslop G., Melzac J., Michaelis L, Ungar G., Vernon J, Walsh J. The value of postural reduction in the initial management of closed injuries to the spine with paraplegia and tetraplegia. Paraplegia 1969;7:179–92.
4. Geisler WO, Jousse AT, Wynne-Jones M, Breithaupt D. Survival in traumatic spinal cord injury. Paraplegia 1983:21:364–373.
5. Spinal Cord Injury Statistics. Experience of the Regional Spinal Cord Injury Systems. 1982; Good Samaritan Medical Center, Phoenix, Arizona
6. Young JS, Personal communication
7. DeVivo MJ, Fine PR, Stover SL. The prevalence of SCI: A reestimation based on life tables. Model Systems SCI Digest. Winter 1979;1
8. Burke MH, Hicks AF, Robbins M and Kessler H. Survival of patients with injuries to the spinal cord. JAMA 1960;172:121–24.
9. Mesard L, Carmody A, Mannarino E, Ruge D. Survival after spinal cord traum. Arch Neurol 1978;35:78–83.
10. Minaire P, Demolin P, Bourret J, Girard R, Berard E, Deidier C, Eyssette M, Biron A. Life expectancy following spinal cord injury: A ten-years survey in the Rhone-Alpes region, France, 1969–1980. Paraplegia 1983;21:11–15.
11. Glenn, WWL. On diaphragm pacing. N Engl J Med 1987;317:1477 (letter to the Editor and further references).
12. Glenn WWL, Phelps ML, Elefteriades JA, Dentz B, Hogan JF. Twenty years of experience in phrenic nerve stimulation to pace the diaphragm. PACE 1986;9:780–4.
13. Wilmot C. Personal Communication.