Long-term morbidity and mortality after spinal cord injury: 50 years of follow-up

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Objective: To determine the long-term mortality rate and the types of morbidity among all people with spinal cord injuries (SCI) that occurred during the 1948 Israel War of Independence.

Method: Chart review and telephone interviews for collecting demographic data, injury characteristics, marital status, physical activities, employment, morbidity and mortality.

Results: Twenty individuals with SCI (19 males, one female). There was no regular follow-up during the first 20 years post injury. The most frequent morbidities were genito-urinary, cardiovascular and decubiti. Ten (50%) had died during this overall follow-up interval. The average age at death was 60 years. The cause of death was cardiovascular in six, neoplastic disease in two, pneumonia in one, and one died from an unknown cause.

Conclusions: The data analysis showed that those who died participated less in physical activity and fewer were employed as compared to the survivors.

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Introduction

The morbidity rates for people with spinal cord injury (SCI) have considerably and gradually decreased during the past five decades.¹ Consequently, the survival rates have improved.² Modern emergency medical services, new medications and surgical procedures, antibiotics to combat infections and finally improved rehabilitation policies and services, have contributed to this progress.

In 1949, upon the invitation of the government of the new state of Israel, Sir Ludwig Guttmann, the father of modern SCI care, came to Israel and gave his expertise on the Israeli spinal cord patients injured during the 1948 War of Independence.

Since then we followed these individuals and their data were recorded. The main goal of our study was to determine the long-term survival rate and types of morbidity among the veterans who survived at least 1 year after sustaining a SCI.

Patients and methods

The Sheba Medical Center is a first level trauma center and includes a National SCI Rehabilitation Unit. Hospital records and follow-up charts were reviewed for all SCI patients from the Israel War of Independence (1948). All of them remained in our follow-up during the 50-year period. The only study

criterion was 1-year post-injury survival. Twenty individuals with SCI met the inclusion criterion.

The data collected includes demographic and social information before and after the injury: age at injury, gender, marital status, employment status and regular physical activity. 'Regular' was defined as engaging in physical activity at least 6 h per week. Causes and severity of the spinal injury were recorded. The severity of the spinal injury was determined by the level of neurologic injury, the completeness of injury and by the American Spinal Injury Association (ASIA) impairment scale.³

The morbidity assessment was made from the registered data in the charts and by interviewing the participants. The dates and the causes of death were established by phone interview of the family and by medical certificates of death. The types of morbidity and the causes of death were analyzed according to the International Classification of Diseases: Ninth Edition (ICD9).⁴

Results

The results of the descriptive analyses are found in Table 1. There were nineteen males and one female. The mean age at injury was 22.6 years with a range of 17–36 years. Most sustained the injury as a result of a gun shot wound (GSW). Other causes of injury were motor vehicle accidents and a fall from a height. The most common neurological deficit was paraplegia T2–

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T9, ASIA A. There were no individuals with complete tetraplegia. Following the injury they remained hospitalized for an average of 3 years. There was no regular follow-up during the first 20 years post injury. At subsequent follow-up, 75% had married, 75% were employed and 45% were involved in regular physical activity. The most frequent morbidities were genitourinary, cardiovascular and pressure sores. Ten (50%) died during this interval (Table 2). The average age at death was 60 years (range 55–65). Of those who died, the distribution of neurological deficits closely corresponded to the characteristics of the overall group. The main cause of death was cardiovascular in six cases: myocardial infarction and cardiac insufficiency in five, and a stroke in one. The other causes of death were cancer, pneumonia, and in one instance the cause of death remains unknown.

The main types of morbidity are found in Table 3. There were no significant morbidity differences between the living and the deceased patients. However, physical activity and occupational status were significantly different between the two groups. Those belonging to the surviving group were more likely to have performed regular physical activity and to have been in regular employment at a rate of two-to-one compared to the deceased individuals (Table 4).

Table 1 Demographic characteristics

<i>Variables</i>	<i>Numbers</i>
Gender	
Male	19 (95%)
Female	1 (5%)
Age at injury	22.6 (17–35)
Cause of injury	
Gun shot wound	15 (75%)
Motor vehicle accident	4 (40%)
Fall from height	1 (5%)
Neurologic deficit	
Paraplegia ASIA A	13 (65%)
Paraplegia ASIA C-D	4 (20%)
Tetraplegia ASIA C	3 (15%)

Table 2 Characteristics and causes of death

<i>Variables</i>	<i>Numbers</i>
No. of deceased	10 (50%)
Age at death	60 (55–65)
Gender	Male = 10; Female = 0
Causes of death	
Ischemic heart disease	3 (30%)
Nonischemic heart disease	2 (20%)
Cancer	2 (20%)
Stroke	1 (10%)
Pneumonia	1 (10%)
Unknown	1 (10%)
Neurological deficit	
Paraplegia ASIA A	6 (60%)
Paraplegia ASIA C	3 (30%)
Tetraplegia ASIA C	1 (10%)

Table 3 Main types of morbidity

<i>Morbidity</i>	<i>Numbers</i>
Urinary tract infections	17 (85%)
Pressure sores	12 (60%)
Genitourinary	12 (60%)
Cardiovascular	11 (55%)
Metabolic	9 (45%)
Musculoskeletal	9 (45%)
Gastrointestinal	7 (35%)

Table 4 Marital status, employment and physical activity – numbers before and after the injury

<i>Variables</i>	<i>Before</i>	<i>After</i> <i>Living</i>	<i>Deceased</i>
Marital	3 (15%)	9 (90%)	6 (60%)
Employment	No data	10 (100%)	5 (50%)
Physical activity	No data	6 (60%)	3 (30%)

Discussion

The 20 people described in this study represent all the SCI population from the Israeli Independence War in 1948–1949. During the 50 years since, they had acute treatment, rehabilitation and the follow-up program done at the same medical facility. In the first 3 years after the injury they lived in the hospital in a special ward. In the period of time between their discharge until 1972 they had only sporadic spinal injury-oriented medical treatment and follow-up. Most of the medical care that they did receive was for the treatment of acute medical problems. In 1973 the National Spinal Cord Rehabilitation Unit was established and a regular follow-up program was initiated. This program was SCI oriented and thus focused on the specific problems related to the spinal cord injury, such as spasticity, pain, wound care and urinary management. In 1983 a multidisciplinary annual follow-up program was started, designed to manage both SCI related problems and other medical conditions, including secondary and tertiary prevention of chronic diseases. Compared to other studies,^{5–8} our data is unique since it describes a homogeneous group of people with a very similar social, medical and economic background, before and after the injury. In fact, at the time of injury, all were young soldiers, in good physical and medical condition. They all belonged to the lower economic class of new immigrants who had arrived in Israel at that time. After the injury, they were under the auspices of the veterans' administration, and as such they received ongoing social-economic support in addition to full coverage of all medical treatment.

British and American studies^{5,7} have investigated large sample populations and have correlated between severity of injury, age at injury, gender, time and type of the first treatment, and mortality and morbidity rates and life expectancy. Heart diseases, respiratory,

neoplastic conditions and infections were the most common underlying causes of death. Other studies^{9–12} have confirmed these findings.

Our study has several surprising and important findings, including the high percentage of individuals dying at a relatively young age and the significant differences in occupational status after the injury between the two groups. Other authors^{13,14} have described the completeness of the injury as affecting mortality, but the differences were not apparent in this relatively small cohort. In our study those who died participated less in physical activity. In the able-bodied population it is already known that a sedentary lifestyle and physical inactivity results in general deconditioning of the cardiovascular and other organ systems, and in a reduced work capacity.¹⁵ Many of the physiological alterations affecting the cardiovascular system have multiple factors, including diet, level of physical activity and chemical use. Furthermore, Erikssen *et al*¹⁶ concluded in their study that change in physical fitness in healthy middle-aged men is a strong predictor of mortality and that even minor improvements in physical fitness are associated with a significantly lowered risk of death. Individuals with spinal cord injury, and especially those with complete injury who must adapt to a sedentary lifestyle because of the paralysis, may at an earlier age have the same adverse alterations in functions, which affect the cardiovascular system and lead to premature death. Lack of regular physical activity may increase this risk.

Another factor that may further explain the high rate of deaths, is the sex distribution of 19 males and only one female in this group. The data from the National Database shows that the male mortality rate is 27% higher than the female rate. In contrast to other studies^{6,17} none of our patients died as a result of septicemia or suicide. This is probably due to the high emphasis placed on patient education and routine long-term follow-up protocols for bladder and skin care. These individuals also had minimal economic or social difficulties.

The small group size, the years of injury (1948–1949), and the nearly uniform male gender of the patients, preclude using the data to predict the long-term survival of the SCI population. The data accumulated by the National Database⁵ shows that the mortality rate was reduced by 42% for persons injured between 1989 and 1992 relative to persons injured between 1973 and 1975.

The people belonging to the living group had had regular employment almost twice as often as those who had deceased. This finding is consistent with Krause's results.¹⁸ Increased life satisfaction associated with employment was already described by Vogel *et al* in individuals who had pediatric spinal cord injury.¹⁹ Holicky *et al* stated that marital status was a significant predictor of better-perceived life satisfaction and quality of life among the SCI long-term survivor.²⁰ Our data showed that more were married

in the living group than in the deceased group. In fact, spouses may play an extremely important role in successful rehabilitation, long-term home care, and quality of life for people with SCI. Krause demonstrated that low overall quality of life is the most significant predictor of mortality among a cohort of more than 300 SCI people.¹⁸

In conclusion, this unique group of individuals formed a homogeneous cohort regarding socio-economic background, community support and access to specialized SCI medical care. Analysis of the demographic data appears to confirm that high overall quality of life, combined with multidisciplinary comprehensive rehabilitation, and long-term follow-up programs leads to maximizing longevity after SCI.

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