Research Paper:
The Veracity of Traumatic Spinal Cord and Related Nerve Injuries in a Developing Country: The Cyprus Case Study

Eleni Tsianaka\textsuperscript{1}\dagger, Nikolay Konovalov\textsuperscript{1}, Andronikos Spyrou\textsuperscript{2}, Alexander Potapov\textsuperscript{3}, Leonid Lichterman\textsuperscript{3}, Michael Spyrou\textsuperscript{4}

1. Department of Spine Neurosurgery, Federal State Autonomous Institution, N. N. Burdenko National Medical Research Center for Neurosurgery, Russian Federation Ministry of Health, Moscow, Russia
2. Federal State Autonomous Educational Institution, N. N. Burdenko National Medical Research Center for Neurosurgery, Russian Federation Ministry of Health, Moscow, Russia
3. Department of Neurotraumatology, Federal State Autonomous Educational Institution, N. N. Burdenko National Medical Research Center for Neurosurgery, Russian Federation Ministry of Health, Moscow, Russia
4. Department of Neurosurgery, Ygia Private Hospital, Limassol, Cyprus

\textsuperscript{\dagger} Corresponding Author:
Eleni Tsianaka, MD
Address: Department of Spine Neurosurgery, Federal State Autonomous Institution, N. N. Burdenko National Medical Research Center for Neurosurgery, Russian Federation Ministry of Health, Moscow, Russia
Tel: +7 (965) 66484779
E-mail: ariadniq@yahoo.gr

Background and Aim: This is a retrospective epidemiological study, based on ICD-10 system, using statistical data from the Cyprus Statistical Service official archives. To estimate the spinal cord injury incidence and its characteristics like gender preference and hospitalization, in Cyprus people, over a 10-year period of time. The study investigated cases that have occurred within the territory of the Republic of Cyprus.

Methods and Materials/Patients: The data from the Cyprus Statistical Service official archives were reviewed based upon the ICD-10 searching, using annual reports, from 2005 to 2014. The extracted information included the number of hospitalized patients, using ICD-10 codes S14, S24 and S34, sex and days of hospitalization. In order to report the incidence rates, we used the Cyprus Statistical Service official demographic data.

Results: The Mean Spinal Cord and the related Nerves Injury (SCI and NI) incidence were calculated to be 0.24%. The Mean SCI and NI male incidence rate was 0.158 %. The mean SCI and NI female incidence rate was 0.076 %. There were 2.8 days of hospitalization per every SCI and NI patient per year.

Conclusion: Based on the study results, it seems advisable to have a National Spine and Spinal Cord Injury registry, in order that different parameters be correlated in a more effective way. The study highlights the need for a well-organized trauma and rehabilitation center which would be of great benefit for the health system of the country. Furthermore, this information can be useful in future health economic studies related to the SCI and NI.

Keywords: Trauma, Spinal cord, Nerves, Injuries, Spine, Biostatistics

ABSTRACT

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1. Introduction

Spinal cord injury is usually followed by personal, emotional, and physical stress. That problem affects patients, their families, all sectors of the health care system (from primary health care to rehabilitation) and both the employment and pension schemes in each country. Injuries can occur at any spine level. Spinal cord injuries can be complete or incomplete thus causing problems in mobility and or sensation of the injured person; conditions that can be fatal in some cases. Specialized trauma centers, including spine trauma units, have been developed in countries with efficient health systems. Within such health systems, the specialized rehabilitation centers are an integral part of the system, prioritizing the patient’s well-being. Subsequently, the system saves a lot of money which can then be used for other purposes.

In our study, we used all available statistical information from the official government archives of Cyprus, in order to investigate the spinal cord injury incidence and its structural characteristics in relation to sex and hospitalization in this country, over a 10-year period. The Spinal Cord and the related Nerves Injuries (SCI & NI) were found to be 0.24% of the total population. They were 0.158 % for men and 0.076 % for women, respectively. The mean stay in the hospital for these patients was 2.8 days.

This study highlighted the need for a National Spine and Spinal Cord Injury registry in order that different parameters be correlated in a more effective way. The study highlights the need for a well-organized trauma center and a rehabilitation center which would benefit the country’s health system a lot. Furthermore, this information can be useful in future health economic studies related to the SCI and NI and could pave the way for further research.
analytical reports from the Cyprus Statistical Service, have reliably and continuously been published by the Republic of Cyprus since 1980. The collected data were categorized based on the ICD-10 searching, using annual reports, from 2005 to 2014. The data included all trauma patients (including only initial admission for every patient) experienced SCI and/or NI, from January 2005 to December 2014 (10-year period) and have been hospitalized at public or private hospitals of the Republic of Cyprus.

For that purpose, the injured cases based on ICD-10 codes were identified: S14 (injury of nerves and spinal cord at neck level), S24 (injury of nerves and spinal cord at thorax level) and S34 (injury of lumbar and sacral spinal cord and nerves at abdomen lower back and pelvis level) [10]. The study excluded congenital spinal defects and spinal cord injuries (ICD-10 code P11.5). Where cases were identified as using the ICD-9 system, we translated them into corresponding ICD-10 code [10, 11].

The extracted information included a number of hospitalized patients, using the above codes, sex and days of hospitalization. In order to report the rates, we used the Cyprus Statistical Service demographic data [8, 12]. The collected data included a total of both male and female population in each year. The statistical analysis was performed in SPSS V. 22.

### 3. Results

The total population in the Cyprus Republic has increased from 766400 in 2005 to 865900 in 2012, with a mild decline after that year (847000 in 2014). After we conducted a study based on hospitalized SCI and NI patients, in all of the Republic of Cyprus hospitals (public and private), during a 10-year period of time (2005-2014), we found SCI and NI patients range between 1309 and 2446 per year, with a mean±SD of 1911.00±366.023 per year. The rate of SCI and NI incidence (%) ranged between 0.15% in 2012 and 0.31% in 2007 in the total population. The Mean±SD SCI and NI incidence was calculated as 0.24±0.05 (Tables 1 and 2).

The male and female incidence rates of the S14/24/34 ICD-10 group ranged from 0.10% to 0.21% (Mean: 0.158%) for male cases and from 0.05% to 0.10%, (Mean: 0.076%) for the female cases (Table 2). Another factor which we studied, was the days of hospitalization; 2012 had the minimum days of hospitalization for S14/24/34 patients (3313 days) whereas 2007 had the maximum days of hospitalization of our group patients as 8004 days (Table 1). The mean hospitalization days per year of SCI and NI patients were 420.9 days (Table 2).

### 4. Discussion

Spinal cord trauma has serious consequences for the patient, his/her family and the society. This huge bur-

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**Table 1. S14/24/34 incidence, gender incidence and days of hospitalization per year (years 2005-2014)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Population</th>
<th>S14/24/34 Patients</th>
<th>S14/24/34 Male</th>
<th>S14/24/34 Female</th>
<th>Incidence (%)</th>
<th>Days of Hospitalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>766400</td>
<td>2136</td>
<td>1424</td>
<td>712</td>
<td>0.28</td>
<td>0.19</td>
</tr>
<tr>
<td>2006</td>
<td>778700</td>
<td>2292</td>
<td>1559</td>
<td>733</td>
<td>0.30</td>
<td>0.20</td>
</tr>
<tr>
<td>2007</td>
<td>789300</td>
<td>2446</td>
<td>1655</td>
<td>791</td>
<td>0.31</td>
<td>0.21</td>
</tr>
<tr>
<td>2008</td>
<td>796900</td>
<td>2150</td>
<td>1448</td>
<td>702</td>
<td>0.27</td>
<td>0.18</td>
</tr>
<tr>
<td>2009</td>
<td>803200</td>
<td>1718</td>
<td>1188</td>
<td>530</td>
<td>0.21</td>
<td>0.15</td>
</tr>
<tr>
<td>2010</td>
<td>839800</td>
<td>1993</td>
<td>1367</td>
<td>626</td>
<td>0.24</td>
<td>0.16</td>
</tr>
<tr>
<td>2011</td>
<td>862000</td>
<td>1456</td>
<td>944</td>
<td>512</td>
<td>0.17</td>
<td>0.11</td>
</tr>
<tr>
<td>2012</td>
<td>865900</td>
<td>1309</td>
<td>851</td>
<td>458</td>
<td>0.15</td>
<td>0.10</td>
</tr>
<tr>
<td>2013</td>
<td>858000</td>
<td>1681</td>
<td>1138</td>
<td>543</td>
<td>0.20</td>
<td>0.13</td>
</tr>
<tr>
<td>2014</td>
<td>847000</td>
<td>1929</td>
<td>1287</td>
<td>642</td>
<td>0.23</td>
<td>0.15</td>
</tr>
</tbody>
</table>
den can be both psychologically and economically [13]. The challenge for all physicians is to make the patient as independent as possible. Prevention is the area where society must indulge on to decrease the incidence of spinal cord injury.

To accomplish this objective, the incidence of spinal cord trauma has to be determined first and then be correlated with various variables. The study of spinal cord injury related to whole country demographics and based on the ICD-10 classification would be of great interest. Our study presents an interesting analysis of SCI and NI characteristics, based on the official demographic data of the country (Republic of Cyprus). Nowadays, in Cyprus, 80% of the health system services are provided by the public sector and 20% by the private sector. The patients’ distribution follows the same pattern. However in Cyprus, the doctor’s distribution is the opposite (80% of them are employed in the private hospitals and only 20% in public hospitals).

All kinds of trauma patients are immediately transferred to public hospitals. The majority of them remain in public hospitals and only some of them are transferred to private hospitals, upon the request of the patient or his or her family. All efforts to evaluate and establish a well-organized trauma center with international standards at the present moment has been unsuccessful.

Public hospitals are entrusted with the responsibility of addressing trauma patients. Analyzing the data with regard to the ICD-10 groups, we find that the S14/24/34 incidence in general population is 0.24%, which is considered to be very high, compared with other countries studied. Based on the international published data of developed countries, this rate ranges between 0.01 and 0.13 cases per 1000 people of the general population [14]. Regarding the developing countries, the incidence ranges between 0.021 (Saudi Arabia) and 0.13 (Bulgaria) [7]. In Europe, the spinal cord injury incidence ranges between 0.13 (Bulgaria) and 0.01 (Denmark) [15-23]. According to our results, this incidence is about 2.4 cases per 1000 people of the general population (Table 2). However, in our results (based on ICD-10 coding) the incidence refers not only to spinal cord injury, but to nerves injury too.

The differences in study design (data source, collection and extraction) can explain the different results. Therefore, the inconsistencies in incidence is justified to a certain extent. On the other hand, our results refer to hospitalized patients, unlike the international data, which refer to all spinal cord injury patients. Besides, the Cyprus witnesses a large number of hospitalized patients which might be unnecessary that results in higher cost for the national health care system. Additionally, in some developing countries, low incidence can be related to the high mortality during pre-hospital time [24].

The realization of Advanced Trauma Life Support (ATLS) courses in Cyprus, has minimized prehospital mortality. In Cyprus, all trauma survivors are transferred to public general hospitals, where the vast majority are examined by orthopedics, general surgeons or general practitioners. In Cyprus, there is only one neurosurgical department in a public hospital, so in many cases, other physicians and not neurosurgeons are involved in spine trauma cases, resulting in high hospitalization rates. However, the difference remains huge and that is the reason why we cannot disregard the fact that Cyprus is a left-hand-driving country, with overnight entertainment (including alcohol consumption), a lot of motorbikes (due to the small distances between cities), and no public transportation. These might explain the high trauma rates, including spinal cord injuries. The male predisposition has been reported in all studies, but the ratio of the developing

### Table 2. SCI and NI patients incidence rates and days of hospitalization

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCI &amp; NI patients incidence</td>
<td>10</td>
<td>0.15</td>
<td>0.31</td>
<td>0.2360±0.05420</td>
</tr>
<tr>
<td>SCI &amp; NI patients gender incidence</td>
<td>10</td>
<td>0.10</td>
<td>0.21</td>
<td>0.1580±0.03736</td>
</tr>
<tr>
<td>SCI &amp; NI patients days of hospitalization</td>
<td>10</td>
<td>3313</td>
<td>8004</td>
<td>5420.90±1477.256</td>
</tr>
</tbody>
</table>

countries (Mean M:F Ratio: 4.8) is much higher than the
developed ones (Mean M:F Ratio: 3-4) [24]. In Cyprus,
the ratio shows male predisposition (2:1), but it is lower
compared with other developing countries.

This low ratio might be due to protective initiatives
against dangerous male activities or rise of women be-
ing exposed to danger. Future studies of mechanisms of
SCI and NI should clarify this issue. Additionally, there is
a slight decrease in incidence, in both genders, over the
years, probably reflecting to the continuing improve-
ment of living conditions (Table 1). Generally, multiple-
trauma patients have the worst outcome, in contrast to
uncomplicated spine trauma patients [25]. Co-injuries,
when not leading to death, complicate the rehabilita-
tion procedure [26-28]. Evidently that leads to longer
hospitalization of the patients. According to our data,
the hospitalization for SCI and NI patients was 420.90
days per year (Table 2). The hospitalized SCI and NI pa-
tients per year was about 1911 i.e., the corresponding
days of hospitalization for every SCI and NI patient per
year (hospitalization/ patient/ year) was approximately
2.8 days (Table 2).

As regards the international data, hospitalization for
any pathology is about 4.9 days and for spinal cord in-
jury 19 days [29]. Surprisingly, we discovered that the
spinal cord and nerve injury groups have a much shorter
hospitalization stay, compared with the international
data. The results in this area have high standard devia-
tion which represent great data variation. We suppose
that a large number of factors determine the length of
hospitalization in these cases, such as clinical presenta-
tion, need for operation, management difficulties when
they do not fall within clear guidelines, availability of re-
habilitation centers and so on.

Once more, we feel the necessity of a well-organized
trauma center, with inter-specialization on spine trau-
a. Moreover, the establishment of a rehabilitation
center, where all SCI and NI patients can be transferred
to (after they have been discharged from the hospital)
can further decrease the days of hospitalization, gaining
resources for the health system of the country.

Despite the numerous advantages of our study (based
on national documentation, reliable source of informa-
tion, long period of study time i.e., ten years, results
referring to a whole country), there are still some limi-
tations. The first limitation is the use of ICD-10 system,
to collect and categorize the data. It is relatively a rigid
system. Using that system, a multiple-trauma patient
cannot be well defined within terms of their clinical con-
dition. Besides, ICD-10 system provides a poor patient
description, because it cannot describe the patient’s
condition as a whole, but it focuses only on a single di-
mension diagnosis.

The ICD-10 system is primarily established based on
the needs of health economic analysis, not taking into
consideration health, social or medical statistical related
needs. Our data collection tool was national archives in
a retrospective study. Thus, it was impossible to cor-
relate data independently. For example, there was no
information about trauma mechanism in these patients
that could be of great value. In addition, our study de-
sign could not be as flexible as we would have liked it
to be, because national statistical records limited the
structure of the data.

One can argue that our studied parameters were al-
most predefined (there was no ability to study and cor-
relate parameters such as age and mortality), so we
missed the opportunity to make groups, based on injury
level and correlate that with sex, age and mortality rate,
which would be important. Furthermore, in official doc-
uments, there is no available data about those patients’
mortality etiology, clinical condition and outcome after
hospital discharge, rehabilitation process or even late
mortality. Finally, our study just included hospitalized
patients, so we cannot estimate the incidence of mild
SCI and NI, in the patients who did not seek medical
help or discharged from the Emergency Department
without hospitalization. A national registry for spine
trauma patients and a future prospective study with
clinical orientation could solve most of these limitations.

5. Conclusion

This is an epidemiological study on traumatic SCI and
NI patients at a country level (Republic of Cyprus), ana-
lyzing incidence, gender distribution and hospitaliza-
tion time, trying to find the SCI and NI characteristics,
and picturing a general view of the situation. Based on
the study results, it seems advisable to have a National
Spine and Spinal Cord Injury registry, in order that dif-
ferent parameters be correlated in a more effective
way, for example, trauma mechanism with gender pre-
disposition. Obviously, a national Spine and Spinal Cord
Injury registry could be a very useful tool to effectively
prevent this kind of injuries. That can be a part of a
wider health strategy project, given the country has the
ability to have resources (human and economic). More-
over, a well-organized trauma center, according to the
international standards, would be very helpful to avoid
unnecessary admissions, minimize hospitalization time and risk of death and disabilities.

All in all, a well-organized rehabilitation center can be of great benefit for the health system. Despite the limitations, our study can be very useful in understanding the spinal cord injuries profile and its basic characteristics to design not only a preventing guide, but also an educational tool for these patients. Furthermore, the results of our study can help the health strategy plan of Cyprus and support future health economic studies (our study is epidemiological, not economic one), related to spine and spinal cord injuries.

Ethical Considerations

Compliance with ethical guidelines

It is a biostatistical analysis which didn’t involve patients directly.

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Authors contributions

All authors have read and approved the manuscript.

Conflict of interest

The authors declared no conflict of interest.

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