Traumatic brain injury, psychiatric disorders and suicide: A population-based study of suicide victims during the years 1988–2004 in Northern Finland

ARJA MAINIO1, TIINA KYLLÖNEN1, KAISA VIIMO1, HELINÄ HAKKO1, TERTTU SÄRIOJA2, & PIRKKO RÄSÄNEN1

1Department of Psychiatry and 2Department of Forensic Medicine, University of Oulu, Finland

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Abstract
Background: Depression and substance abuse are common among patients with traumatic brain injury (TBI). However, previous studies have not examined the temporal association between psychiatric disorders, TBI and suicide.
Objective: To study the prevalence of TBI injury among suicide victims; to determine the association of suicide, psychiatric disorders and TBI severity; and to examine the effect of pre- and post-traumatic psychiatric disorders on their remaining life-time.
Methods: This study examined all suicides (n = 1877) committed during a 16-year period in the province of Oulu, Finland. The information of suicide victims was extracted from the official death certificates and the National Hospital Discharge Registers.
Results: TBI was found in 5.5% (n = 103) of the victims. Compared to the victims without TBI, those with TBI had significantly more hospital-treated psychiatric and alcohol disorders. If TBI subjects had comorbid psychiatric disorders, the time period between TBI and suicide was under 3 years in ~90% of victims in this suicide population.
Conclusions: Seriousness of injury, male gender, older age, being unemployed and presence of psychiatric and alcohol disorders are important to identify as possible predictors for suicidal behaviour in TBI patients. Further studies are required to shed light on interventions aimed at better life management.

Keywords: Traumatic brain injury, suicide, depression, alcohol abuse

Introduction
Psychiatric disorders after traumatic brain injury (TBI) cause remarkable disability in the patients’ lives [1–3]. It has also been found that a history of psychiatric disorders before TBI may comprise a risk for depressive disorder after TBI [4]. Several studies indicate the life-time risk for psychiatric disorders, i.e. depression, alcohol abuse, delusional disorders as well as personality disorders [1–5].

Increased suicidal tendencies has been associated with both severe and mild TBI [2, 6]. It is estimated that the risk for committing suicide is 2.7–4.1-times greater among patients with TBI compared to the general population [7]. However, there are only few studies focusing on completed suicide after TBI [7–9].

In the literature, the risk factors for suicidal tendencies in persons with TBI have been reported to be pre-injury psychiatric disturbances, substance misuse, severity of injury and whether the injury has occurred between ages 20–60 [7–11]. Even though the prevalence of TBI is higher in males, suicidal tendencies in females with TBI is supposed to be higher [7]. Epidemiological studies have shown that the predictors for suicide in general are male gender,
depression, substance abuse, presence of somatic disease as well as previous suicide attempts [12–14]. The aim of the present study was to study the prevalence of TBI among suicide victims and to determine the association of suicide with their psychiatric disorders taking into account the severity of traumatic injury. One could evaluate the timing of the psychiatric disorders in relation to the suicide victims’ TBI as well as the impact of the pre- and post-injury diagnosed psychiatric disorders on their remaining life-time.

Materials and methods

This study examined all suicides (n = 1877) committed during the years 1988–2004 in the province of Oulu in Northern Finland. The data on age, gender, dwelling place (population over or below 100,000) and employment status were based on the death certificates from forensic medical-legal investigations. The Ethics Committee of Oulu University has approved the study protocol.

The diagnoses of suicide victims were extracted from the Finnish Hospital Discharge Registers [15]. The International Classification of Diseases (ICD) was used as follows: ICD-9 codes 850–854, 859, ICD-10 codes S060–S068. The sub-groups for further analyses were as follows: (1) Concussion 850, S060 and (2) Cerebral contusion 851, 854, 859, S061-S068 and intracranial haemorrhage 852–853, S065 were classified as ‘lesion’. The TBIs occurring as the result of suicide attempts were excluded.

Psychiatric disorders were categorized as follows; (1) Any psychiatric disorder (ICD-8 and ICD-9: 290–319; ICD-10: F00.00–F99), (2) Depression (ICD-8: 2960, 2980, 3004; ICD-9: 2961, 2968, 3004; ICD-10: F32-F34.1), (3) Schizophrenia (ICD-8 and ICD-9: 295; ICD-10 F20–21), (4) Alcohol-related disorders (ICD-8 and ICD-9: 303; ICD-10: F10).

Methods for suicide among suicide victims were categorized as violent if the method was hanging, drowning, shooting, wrist cutting, jumping from a height and traffic. Non-violent methods were poisoning, gas, other methods. Acute alcohol intoxication was detected in the medical autopsy by a doctor in forensic medicine and entered on the death certificate.

Statistical methods

Differences in categorical variables between sub-groups were investigated by Pearson’s chi-square test or Fisher’s Exact Test. Group differences in continuous variables were assessed with Mann-Whitney’s U-test. The statistical software used was the SPSS for Windows, version 13.

Results

Of the total suicide data population (n = 1877), TBI occurred in 5.5% (n = 103) of the subjects; 20% had brain lesion and the remaining 80% had concussion.

As seen in Table I, the suicide victims with concussion were significantly younger, median (IQR) age at the traumatic event being

### Table I. The characteristics of the suicide victims (n = 1877) according to the TBI in the Finnish suicide database.

<table>
<thead>
<tr>
<th>Characteristics of suicide victims</th>
<th>TBI, n (%)</th>
<th>Overall difference*</th>
<th>Pairwise differences**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lesion (L),</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concussion (C),</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No TBI (No),</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>n = 20</td>
<td>n = 83</td>
<td>n = 1771 (%)</td>
</tr>
<tr>
<td>Living in area population below</td>
<td>19 (95.0)</td>
<td>63 (79.5)</td>
<td>453 (81.9)</td>
</tr>
<tr>
<td>100 000</td>
<td>17 (85)</td>
<td>61 (73.5)</td>
<td>1338 (75.4)</td>
</tr>
<tr>
<td>Employed at the time of suicide</td>
<td>5 (25.0)</td>
<td>48 (57.8)</td>
<td>1040 (58.6)</td>
</tr>
<tr>
<td>Median (IQR) age at time</td>
<td>49 (31–55)</td>
<td>27 (18–42)</td>
<td>1338 (75.4)</td>
</tr>
<tr>
<td>of traumatic event</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median (IQR) age in years at the</td>
<td>57 (43–65)</td>
<td>41 (30–50)</td>
<td>1040 (58.6)</td>
</tr>
<tr>
<td>time of death</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Median (IQR) time interval in     | 8 (2–12)   | 11 (4–19)           | 1338 (75.4)           | 0.146 L vs. No 0.005                  | years from TBI to suicide
| Suicide characteristics from death |            |                     |                      |                                      |
| certificates                       |            |                     |                      |                                      |
| Previous suicide attempt          | 2 (10.0)   | 9 (10.8)            | 176 (9.9)             | 0.963                                 |
| Violent method for suicide        | 11 (55.0)  | 59 (71.1)           | 1319 (74.4)           | 0.120 L vs. No 0.049                  |
| Alcohol contributed to the        | 11 (55.0)  | 41 (49.4)           | 761 (42.9)            | 0.308                                 |
| suicide                           |            |                     |                      |                                      |

IQR = Interquartile Range.

*Mann Whitney U-test was used when analysing continuous variables and Pearson test or Fischer exact test in categorical variables; ** only statistical significant pairwise differences are reported in the table.
27 (18–42) years, compared to 49 (31–55) years among those with lesion. At the time of death the suicide victims with brain lesion were significantly older compared to both the victims with concussion and those with no TBI. The victims with lesion had committed suicide 8 (2–12) years after TBI, while the corresponding time among subjects with concussion was 11 (4–19) years. The victims with lesion had used a violent method of suicide significantly less often than those with no TBI.

As seen in Table II, the subjects with TBI, both with lesion and concussion, had suffered significantly more psychiatric and alcohol-related disorder compared to the suicide victims without TBI.

Figure 1 shows the proportions of psychiatric disorders among the suicide victims based on whether these diagnoses were assessed before or after a traumatic event. The first episode of alcohol-related diagnosis had been diagnosed post-traumatically in 71% of subjects with concussion.

When analysing bivariate association between TBI and time to completed suicide (<3 years vs. >3 years), 60% of those with lesion and 40% of

<table>
<thead>
<tr>
<th>TBI, n (%)</th>
<th>Lesion (L), n = 20</th>
<th>Concussion (C), n = 83</th>
<th>No TBI (No), n = 1771 (%)</th>
<th>Overall difference*</th>
<th>Pairwise differences **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any psychiatric disorder</td>
<td>15 (75.0)</td>
<td>50 (60.2)</td>
<td>765 (43.3)</td>
<td>0.000</td>
<td>L vs. No 0.004 C vs. No 0.002</td>
</tr>
<tr>
<td>Depression</td>
<td>6 (30.0)</td>
<td>20 (24.1)</td>
<td>338 (18.1)</td>
<td>0.128</td>
<td></td>
</tr>
<tr>
<td>Schizophrenia</td>
<td>0</td>
<td>9 (10.8)</td>
<td>147 (8.3)</td>
<td>0.285</td>
<td></td>
</tr>
<tr>
<td>Alcohol-related disorder</td>
<td>13 (65.0)</td>
<td>34 (41.0)</td>
<td>322 (18.6)</td>
<td>0.000</td>
<td>L vs. No 0.000 C vs. No 0.000</td>
</tr>
</tbody>
</table>

Note: FHDR: Finnish Hospital Discharge Register.
*Mann Whitney u-test; ** only statistical significant pairwise differences are reported in the table.
those with concussion committed suicide within 3 years after TBI. The corresponding proportions among victims with co-morbid hospital-treated psychiatric disorder were 93% among those with a lesion and 86% among concussion victims \( (p < 0.001, \chi^2 = 25.3, \text{df} = 3) \). In cases where psychiatric disorder occurred before the injury, all the subjects with lesion and 85% of those with concussion committed suicide in the 3-year period after TBI \( (p < 0.001, \chi^2 = 25.9 \text{ df} = 5) \).

**Discussion**

Psychiatric illness has been shown to be associated with an increased risk for TBI [16]. It has earlier been found that a considerable proportion of patients with TBI who later commit suicide are those with a manifested psychiatric disorder even prior to the injury [8]. These findings of pre-traumatic psychiatric history of suicide victims are in line with this conclusion. This study also found that suicide victims with TBI and co-morbid psychiatric disorders diagnosed before TBI committed suicide faster than those whose psychiatric disorders manifested post-traumatically.

Compared to those with lesions, suicide victims with concussion were younger both at the time of the traumatic event and at the time of death. This finding is consistent with other reports that age at the traumatic event is lower among suicide victims with concussion compared to those with a diagnosis of cerebral contusion or traumatic intracranial haemorrhage. It has been suggested that severe traumatic injuries of persons occurring between ages 20–60 are associated with violence, alcohol abuse and other psychosocial factors. In adolescents and old people injuries are found to be milder and they may be caused by accidents in their everyday activities and not be related to psychiatric disturbances [7].

The suicide victims with TBI suffered highly from psychiatric disorders; 75% of victims with lesion and 60% of victims with concussion had been hospitalized due to mental illness in their life-time history, while the prevalence of any psychiatric disorder among victims without TBI was \( \sim 40\% \). Depression was diagnosed in one third of the suicide victims with lesion and one fourth with concussion. The first episode of depression had been diagnosed post-traumatically in two thirds of suicide victims.

The time interval from TBI to suicide in this study, i.e. 8–11 years, was longer than found in the Danish data by Teasdale and Engberg [7], in which the corresponding time interval was slightly over 3 years. In this study all the suicide victims with lesion and comorbid psychiatric disorder before their TBI had committed suicide within a 3-year period after TBI. It has been reported earlier that TBI may cause decades-lasting vulnerability to major depression, alcohol-related disorders and anxiety disorders [1].

In this study, alcohol-related disorders were three (65%) and two (41%) times more prevalent among suicide victims with lesion or concussion, respectively, compared to those without TBI (18.6%). Pre-injury alcohol abuse is known to be present in about half of head-injury patients during the time of the traumatic event [17]. In this study the majority of the alcohol-related disorders had been diagnosed after TBI, i.e. in 71% of the suicide victims with concussion and in 62% of the subjects with lesion. This study shows that patients with TBI are liable to get alcohol-related disorders after TBI and, therefore, they might be vulnerable to suicidal behaviour due to both depression and substance abuse.

In this study, compared to those with no TBI, the victims with a lesion used a non-violent method when committing suicide, a method suggested to be non-impulsive and requiring prior planning [18]. It is known that TBI causes negative effects of disability on a person’s life. They may have a large amount of internalized aggression, hostility and negativity and their problem-solving skills are decreased [6, 10]. They may have decreased intellectual and neuropsychological resources to cope with their surroundings [10]. Thus, the use of maladaptive coping strategies following TBI will lead to hopelessness in the patient’s mind, predicting the possibility of committing suicide as a pathological coping strategy. From a psychiatric point of view it is important to go through a grieving process during which the patient can come to terms with the remarkable change that has occurred in his life and the decreased level of physical, emotional and intellectual challenge be realized [11].

The limitations of this study were that all diagnoses were obtained from the national register-based information on hospital treatments, and thus only traumatic injuries and psychiatric disorders severe enough to require hospitalization were analysed. The suicide victims may, therefore, have been treated for mild TBI or psychiatric disorders, especially alcohol-related disorders in outpatient care, but became disease-free subjects in this study setting. Unfortunately, there are no common national registers for outpatient treatments in Finland and the percentage of wrongly classified patients, even if small, remains unknown.

The strengths of the present study were that all suicides committed in the province of Oulu during the study period were included and evaluated. Thus, the study was neither limited to a certain age
group nor to otherwise incomplete suicide data. In addition, the Finnish Hospital Discharge Register has been shown to be a reliable source of information in scientific research on various kinds of hospital treatments of patients [15].

This study presents the association of TBI, psychiatric disorders, post-traumatic depression and alcohol abuse to accelerated suicide process in subjects’ life. The majority of subjects with TBI suffering from co-morbid psychiatric disorder committed suicide during a 3-year period after the traumatic event. Psychiatric consultation is thus recommended for TBI patients with affective disorders and co-morbid alcohol abuse in clinical work at neurosurgical, neurological and neurorehabilitation units when follow-up of brain trauma patients is designed. Although the prevalence of TBI in this suicide population was not much higher than the prevalence of TBI in the general population, these findings highlight the greater prevalence of their co-morbid psychiatric disorders compared to other suicide victims. It is indicated that recognition of depression and treatment with anti-depressants is the most important factor in suicide prevention [19–21]. Special prevention strategies for persons with TBI, such as a model for a staff training workshop, have also been developed [22].

On the basis of these findings, the characteristics of subjects with TBI such as seriousness of injury, male gender, older age, being unemployed and the presence of psychiatric and alcohol disorders are important to identify as possible predictors for suicidal behaviour. Further studies are required to shed light on interventions that could be used to help people achieve better life management.

References