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Severe Traumatic Brain Injury in Austria II: Epidemiology of hospital admissions

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Schweres Schädelhirntrauma in Österreich II: Epidemiologie der Krankenhausaufnahmen

Zusammenfassung. *Ziele:* Das Ziel der vorliegenden Arbeit ist es, anhand von Spitalsaufnahmen die Epidemiologie von Patienten mit schwerem Schädelhirntrauma (SHT) darzustellen.

Patienten und Methoden: Es standen Datensätze von 492 Patienten zur Verfügung, die von 5 österreichischen Zentren in die Studie inkludiert worden waren. Alters- und Geschlechtsverteilung, Ausbildung, Beruf, Unfallort und -mechanismus, Alkoholisierung, Art und Schweregrad des Traumas, Begleitverletzungen, sowie Dauer und Ergebnis der Intensivbehandlung wurden für jedes der beteiligten Zentren evaluiert.

Ergebnisse: Die Stichprobe repräsentiert ungefähr 13% aller Fälle von schwerem SHT, welche während des Studienzeitraums in österreichischen Spitälern behandelt wurden. Das mittlere Alter betrug 48 ± 21 Jahre, und die Mehrzahl (72%) der Patienten war männlich. Die Unfälle ereigneten sich am häufigsten auf der Straße (50%), zu Hause (44%), in freier Natur (10%) und am Arbeitsplatz (7%). Verkehrsunfall (44%), Sturz (< 3 m; 30%), Fall (> 3 m; 11%) und Sportunfall (5%) waren die häufigsten Ursachen. Unter den Verkehrsunfällen waren Autolenker und -beifahrer am häufigsten (45%) betroffen, gefolgt von Fußgängern (20%), Motorradfahrern (19%) und Radfahrern (16%). Für die meisten der untersuchten Variablen fanden sich signifikante Unterschiede zwischen den Zentren. Das SHT war in 10% mit einer Rückenmarksverletzung und in 38% mit anderen schweren Verletzungen kombiniert. Die Intensivstations-Mortalität betrug 31,7%. Zwischen Unfallmechanismus und Verletzungsschwere oder Behandlungsergebnis fanden sich keine signifikanten Korrelationen.

Schlussfolgerungen: Die Epidemiologie des schweren SHT in Österreich ist nicht sehr verschieden von der in anderen Industrieländern. Die häufigste Ursache ist der Verkehrsunfall, was die Bedeutung der Verhütung dieser Unfälle aufzeigt. Die spezifischen Risken Älterer und die Verhütung von Unfällen im häuslichen Bereich verdienen besondere Beachtung.

Summary. *Objectives:* The goal of this paper is to describe the hospital-based epidemiology of severe TBI in Austria.

Patients and methods: Data sets from 492 patients included in the study by 5 Austrian hospitals were available. Age and gender distribution, education, occupation, location of trauma, mechanism of injury, alcohol use, type and severity of injury, associated injuries, length of intensive care unit stay, and intensive care unit outcome were evaluated for each of the 5 centers.

Results: The sample represents roughly 13% of all cases with severe TBI which were treated in Austrian hospitals during the study period. Mean age was 48 ± 21 years, and most patients were male (72%). The most important trauma locations were roads (50%), home (24%), outdoors (10%), and workplace (7%). Transport-related trauma was the most important mechanism (44%) followed by falls < 3 m (30%), falls > 3 m (11%), and sports injuries (5%). Detailed analysis of transport-related trauma showed that car accidents (45%) were most common, followed by pedestrian (20%), motorbike (19%), and bicycle (16%) accidents. Significant differences between the centers were found for most of the variables analyzed. The severe traumatic brain injury was associated with spinal cord injury in 10%, and with severe multiple trauma in 38% of cases. Intensive care mortality was 31.7%. There were no significant correlations between mechanisms of injury and severity of trauma, nor between mechanisms and ICU outcome.

Conclusions: Epidemiology of severe traumatic brain injuries in Austria is not much different from other industrialized countries. Traffic accidents are responsible for the majority of traumas, stressing the importance of road injury prevention. Attention should also be paid to the specific risks of older people and to prevent injuries at home.

Key words: Brain injury, traumatic, epidemiology, Austria.

Introduction

The Austrian Severe Traumatic Brain Injury (TBI) Study was done in five Austrian centers and enrolled a total of 492 patients with severe TBI. Detailed information regarding background, goals, and methods of the study was given in a previous paper [1]. The goal of this paper is to describe the hospital-based epidemiology of severe TBI in Austria.

Patients and methods

The methods of the Austrian Severe TBI Study have previously been described in detail [1]. Briefly, data on accident, prehospital treatment, hospital treatment, and patient status were collected using internet-based databases. All patients admitted to the participating hospitals were included if they fulfilled the criteria for severe brain trauma [2]. Patients who died at the scene, during transport to the hospital, or immediately after admission to the emergency room were excluded.

For this paper, all available data sets were used (492 patients). To estimate the overall incidence of severe TBI in Austria, the number of hospital admissions for TBI from the center in Vienna was evaluated (Table 1). This center was chosen because it received almost all of the patients (97%) by direct transfer, and should therefore reveal a standard distribution of patients with minor, moderate and severe TBI. By comparing this data to that published by Statistik Austria [3], where the degree of severity of TBI is not recorded, a rough estimate of the annual number of severe TBI cases treated in Austrian hospitals could be made. The mortality prediction made possible by the Trauma and Injury Severity Score (TRISS; [4]) was used to calculate the observed vs. expected mortality ratio (O/E ratio); a detailed discussion is provided in the first paper of this series [1].

The XLSTAT add in for Microsoft Excel [5] was used for statistical processing of the data. The analyses were done using standard descriptive statistics and univariate correlation, and the significances of differences between centers were tested by means of Chi-Square for nominal variables, and T-Test as well as one- way ANOVA for numeric variables. A $p < 0.05$ was considered significant.

Results

Annually, about 25.000 people are admitted to an Austrian hospital with a primary diagnosis of TBI (any degree of severity). Results from the trauma center "Lorenz Boehler" in Vienna (Table 1) demonstrate that among patients treated in hospitals, severe TBI has an incidence of about 5%; most patients admitted had only minor TBI, and some had moderate TBI. Based on this incidence data, it can be estimated that every year about 1250 patients (5% of 25.000) with severe TBI are treated in Austrian intensive care units (ICU). Our sample includes 492 patients enrolled by 5 hospitals, and thus represents roughly 13% (492/3.750) of all cases with severe TBI which were treated during the 3-year study period in Austrian hospitals.

Table 1. Degree of severity of TBI in Vienna; given are number of patients and percentage of total

	Period 2001–2003 n / %
All TBI admissions	2265 (100)
Minor TBI	1876 (82.8)
Moderate TBI	259 (11.4)
Severe TBI	130 (5.7)

Severe TBI patients included in the study; *moderate TBI* patients admitted to the ICU but not included in the study; *minor TBI* patients admitted to normal wards.

Age and gender distributions are shown in Fig. 1 and 2. Mean age was 48.2 ± 21.1 years, with a range of 0–102 years. In Graz the rate of patients aged 60 or more was significantly higher than in the other centers ($p < 0.01$) whereas in Vienna the rate of patients with an age ranging between 20 and 39 years was significantly higher ($p < 0.01$). On average 72% (n = 353) of the patients were male and 28% (n = 140) were female, with similar proportions in all the centers but Salzburg, where 40% of patients were female ($p < 0.05$).

Education was registered in 234 patients, of whom 41% (n = 96) had just the compulsory level of education, 52% (n = 122) went through an education of secondary level (high school or apprenticeship), and 7% (n = 16) had a university degree. Occupation was recorded in 314 cases. The largest group were retired persons, representing 34% (n = 108) of total. The second-largest group were "white-collar workers" (26%; n = 81; employees in administrative or clerical positions, salaried professionals) followed by "blue-collar workers" (18%; n = 56, workers performing manual or technical labor). Other occupations (housekeeper, students, self-employed) were rare.

Location of trauma was documented in 391 cases. An overview is given in Table 2. One half of the injuries oc-

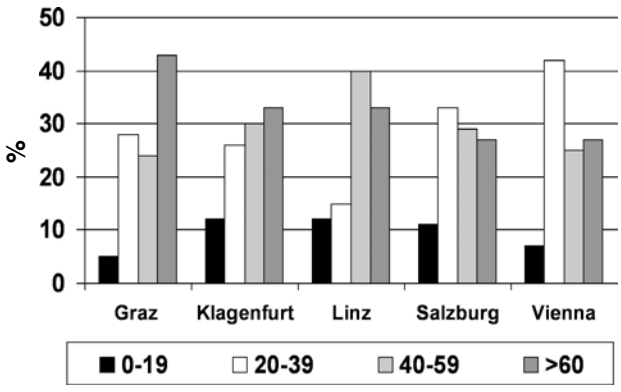

Fig. 1. Proportion (%) of patients in the four age groups by center

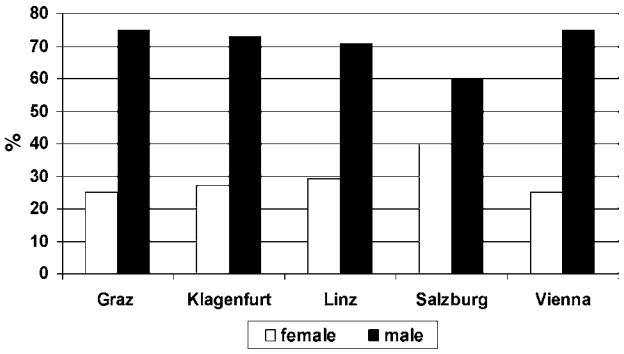

Fig. 2. Proportion (%) of female and male patients by center

curred on roads, including city streets, country roads and highways. The highest frequency of trauma occurring on city streets was observed in Vienna (42%, $p < 0.01$), while the rate of traumatic accidents on country roads was significantly higher in Salzburg (46%, $p < 0.01$). Accidents at home were observed in 24% of all cases. They were significantly more frequent in Graz (44%, $p < 0.01$) and in Linz (44%, $p < 0.05$). Accidents during work, outdoor activities, or sports were less frequent.

An overview on the mechanisms of trauma (473 records available) is given in Table 3. The most important mechanism was transport-related trauma (44%). In almost all centers the second most frequent cause of injuries were falls from less than 3 meters of height, representing 30% of all injuries, typically in people of 60 years or older ($p < 0.01$). The only exception was Graz, where falls from less than 3 meters was the most important mechanism of injury ($p < 0.01$); transport-related trauma was significantly less frequent ($p < 0.01$) in Graz. Less important mechanisms include falls from above 3 meters (11%) and sports-related TBI (5%). Sports accidents were significantly more frequent in Salzburg ($p < 0.01$). Violent causes, as gunshots or assaults, were identified in only 4% of cases. Penetrating injuries, therefore, were extremely rare, and most gunshot injuries were suicide attempts.

A detailed analysis of transport-related trauma is given in Table 4. Accidents involving car drivers and/or passengers were found in 45% of transport-related trauma (19% of all trauma mechanisms). Women were more frequently injured as car drivers or passengers: this caused 26% of the injuries involving female patients, while the same mechanism caused only 16% of the injuries in men ($p < 0.01$). Motorbike accidents contributed 8% of all cases (19% of transport-related trauma). Motorbike accidents were more frequent among people aged 0–19 ($p < 0.01$), while accidents involving car occupants were more frequent among people aged 20–39 ($p < 0.01$). Pedestrians were injured in 9% of all cases (20% of transport-related trauma). People > 60 years were more likely to be victims as pedestrians ($p < 0.01$). Bicycle accidents were responsible for 7% of total injuries (16% of transport-related trauma); this rate was significantly higher in Salzburg, where they represented 12% of all cases ($p < 0.05$).

Information concerning alcohol use was available in 106 cases, 36% of whom (n = 38) reported an association between alcohol ingestion and accident. This rate was significantly higher in Graz, where 67% of the patients had been drunk at the time of injury ($p < 0.05$).

Data on associated medical problems were available in 407 cases; problems were reported in 77 (19%) patients. The most frequent problems were chronic alcoholism (n = 35; 9%) followed by cardiac diseases (n = 17; 4%). Use of aspirin was reported in 11 cases (3%), diabetes, pulmonary and renal diseases were recorded even less frequently. The mortality in the patients with associated medical problems was 37.7% (29/77), while that in patients without associated medical problems was 28,8% (93/323); this difference was statistically not significant.

The average GCS was 5.7 ± 3.0; about half of the patients (51%) had a GCS of 5 or less. The mean ISS was 27.8 ± 13.0; in more than one third of the cases (38%) an ISS > 32 suggesting severe additional injuries was recorded. Information on associated spinal cord injuries was available in 481 cases. In 8% (n = 37) an incomplete spinal cord injury was recorded, and in 2% (n = 9) a complete spinal cord lesion was diagnosed. There were no statistically significant differences between the centers. There were no significant correlations between mechanisms of injury and severity of trauma, as well as between mechanisms and ICU outcome.

For patients included in the study, the average stay in the ICU was 17 days (1–97 days). ICU mortality was 31.7%. Data on ICU outcome as well as a mortality prediction by TRISS were available in 392 cases. Predicted mortality was 37%, while actual mortality was 30.6%

Table 2. Location of trauma by center; given are number of patients and percentage of available records (n = 391)

Center	Location					
	Road	Home	Workplace	Outdoor	Public area	Sports
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Graz	25 (30)	37 (44)	8 (10)	12 (14)	1 (1)	1 (1)
Klagenfurt	33 (44)	23 (30)	7 (9)	9 (12)	4 (4)	0 (0)
Linz	9 (34)	12 (44)	1 (4)	4 (15)	1 (4)	0 (0)
Salzburg	51 (65)	10 (13)	0 (0)	11 (14)	2 (3)	5 (6)
Vienna	79 (62)	13 (10)	14 (11)	5 (4)	12 (10)	2 (2)
Total	197 (50)	95 (24)	30 (7)	41 (10)	20 (5)	8 (2)

Table 3. Mechanism of trauma by center; given are number of patients and percentage of available records (n = 473)

Center	Mechanism						
	Transport-related	Fall < 3 m	Fall > 3 m	Sports	Assault	Gunshot	Other
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Graz	25 (20)	63 (50)	11 (9)	2 (2)	1 (1)	6 (5)	17 (14)
Klagenfurt	42 (47)	24 (27)	8 (9)	6 (7)	3 (3)	3 (3)	3 (3)
Linz	22 (46)	12 (25)	7 (15)	1 (2)	2 (4)	1 (1)	3 (6)
Salzburg	56 (64)	12 (14)	6 (7)	12 (14)	0 (0)	0 (0)	2 (2)
Vienna	61 (50)	29 (24)	18 (15)	1 (1)	3 (2)	1 (1)	10 (8)
Total	206 (44)	140 (30)	50 (11)	22 (5)	9 (2)	11 (2)	35 (7)

(120/272), resulting in an O/E ratio of 0.83. The O/E ratios in Klagenfurt (0.71), Salzburg (0.72) and Vienna (0.79) indicated a lower mortality than predicted. The centers in Linz (1.01) and Graz (1.09) had O/E ratios within the expected range. With regard to outcome no significant differences between the centers were found.

Discussion

Six of the 15 leading causes of death in people aged 15–44 years are trauma-related. In addition, trauma and injury are major contributors to disability [6]. According to international standards, deaths due to accidents or violent causes are recorded by external cause and not by lesion location. Due to this it is impossible to get exact data about mortality from TBI in Austria from official statistics. In addition, data on hospitalization are difficult to interpret since they do not report the severity of TBI. However, it is possible to make a rough estimate of the extent of the "TBI epidemic" in Austria from data published in the Health Year Book of Austria [3] and the distribution of TBI severity in Vienna. We estimate that annually about 1250 cases with severe TBI are treated at Austrian hospitals; this number is quite close to the 1280 cases we calculated in a previous study [7] using a different method.

In 2002 5.7% of all deaths in Austria were due to "Injury and Poisoning", representing the 3rd leading cause of mortality after "Cardiovascular Diseases" and "Cancer", and the leading cause of death for people aged 1–45 years. The Standardized Death Rate (SDR) in the population was of 40.8/100.000, with a difference between males (SDR = 63,3/100.000) and females (SDR = 20.5/100.000). Most deaths were caused by accidents (SDR = 21.7/100.000), mainly transport accidents (SDR = 10.8/100.000) and falls (SDR = 6.4/100.000). The rate for suicide and self-inflicted injuries (SDR = 15.2/100.000 inhabitants) was surprisingly high. Hospitalization rates for 2001 document 25406 people admitted to a hospital with primary diagnosis of "Intracranial Injury", representing 1.06% of total hospital admissions in Austria [3]. Of these patients, almost two thirds (62.9%) were aged 0–44.

The results of this study are not too different from that published in previous studies from other countries. However, it is difficult to compare observations from different studies because of different methodologies used, as well as of various inclusion criteria adopted. Only a few studies actually focused on characteristics of severe TBI [8–10], while most were based on observations of brain trauma without differentiating trauma severity.

Our study population was older than that described in most other reports, with a high rate of people aged more than 60 years. Many studies reported higher proportions of children or patients aged less than 20 [9–21], which in our study represented only 8%. Some of these studies report findings from developing countries [18–21] where

Table 4. Transport-related trauma by centers; given are number of patients and percentage of total (n = 206)

Center	Mechanism			
	Car driver or passenger	Motorbike	Pedestrian	Bicycle
	n (%)	n (%)	n (%)	n (%)
Graz	11 (44)	6 (24)	4 (16)	4 (16)
Klagenfurt	18 (43)	8 (19)	10 (24)	6 (14)
Linz	11 (50)	3 (14)	1 (5)	7 (32)
Salzburg	21 (38)	11 (20)	13 (23)	11 (20)
Vienna	31 (51)	11 (18)	14 (23)	5 (8)
Total	92 (45)	39 (19)	42 (20)	33 (16)

children usually represent a population with higher risk of TBI. Another factor may be that our study focused on severe TBI: a French study [8], also focused on severe TBI, showed a proportion of 8.5% of patients aged 0–14, too.

The male to female ratio observed in our study was of 2.5:1, similar to all other published evidence, where males represent at least the 60% of all severe TBI victims.

Our study demonstrated a high frequency of victims with a medium or elementary level of education, possibly suggesting an association between TBI and lower education, as already shown in other studies [16]. No significant association with special professions was observed. It could be stated that most of the injuries happened to patients belonging to the "middle-class", but this is the largest social group in Austria.

In accordance with previous studies, road traffic accidents were responsible for the majority of TBIs, followed by falls [9–11, 22–24]. The incidence of violence related injuries observed in Austria was lower than in most other studies [13, 18–21, 25]. It is well known that these injuries are more frequent in economically depressed areas and highly populated cities, which is not typical for Austria. The relationship of mechanisms of injury to age observed in our study is confirmed by previous reports, too, depicting a higher rate of falls in people aged over 65 years [13, 14, 23, 26, 27], and a higher rate of car and motorbike accidents among young people [12, 13, 18, 27].

Most cases of severe TBI were blunt, as already observed by the French study [8] on similar patients, and were associated with spinal cord injuries in 10% of the cases, with severe injuries to other body parts in 38%.

In more than 30% of all cases where alcohol levels were recorded, an association between alcohol ingestion and accident was noted. This rate is quite high; previous papers stated rates between 1% and 33% of cases [21, 28]. Not enough data about drug use, seat belt and car seats, and helmet use were recorded to obtain valid results; further investigations on those aspects could be useful for an evaluation of preventive measures.

ICU mortality was 31.7%, very similar to that reported by Masson et al. [8] in a study on severe brain injuries (30%), quite low compared to a German study which gave an average mortality of 49.9% for comatose patients [22], and to another French study where mortality was 52% [9]. The low O/E ratio demonstrated that the Austrian hospitals performed better than predicted by the TRISS score. Masson et al. [8] reported a median length stay in ICU of 14 days for people with severe TBI, and of 37 days for very severe trauma, which correlates well with the median stay of 17 days found in our study.

In conclusion, epidemiology of severe TBI in Austria is not much different from other industrialized countries. Traffic accidents are responsible for the majority of trauma, stressing once again the importance of road injury prevention. Attention should also be paid to the specific risks of older people and to preventing injuries at home. A more detailed study of some TBI risk factors, such as alcohol, drugs, helmet, car seat (not usually recorded), and seat belt use, as well as further investigations into local differences, would probably be useful for better planning of prevention of severe TBI.

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