

Incidence of Hospital-Treated Traumatic Brain Injury in the Oslo Population

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Key Words

Traumatic brain injury · Epidemiology · Incidence · Case fatality rate

Abstract

Background: The aim of this prospective, population-based study is to present the incidence of hospital-treated traumatic brain injury (TBI) in Oslo, Norway, and to describe the severity of brain injuries and outcome of the patients' acute medical care. **Methods:** Data were obtained from hospital admission registers and medical records from May 2005 to May 2006. The initial severity of TBI was measured by the Glasgow Coma Scale. The region is urban with a population of 534,129. **Results:** The 445 patients identified represent an annual incidence of 83.3/100,000. The median age was 29 years. The male:female ratio was 1.8:1.0. The highest incidence of TBI hospitalizations was found in the elderly males and the youngest children. The most common causes of TBI were falls (51%) and transport accidents (29.7%). Intracranial lesions were found more often in the elderly. The case fatality rate was 2.0/100 hospitalized patients and was highest in the elderly. **Conclusions:** The incidence of hospital-treated TBI in this study is considerably lower than that found in previous studies from Norway and Scandinavia. Despite the apparent decline in TBI hospitalization rates, our findings should also draw attention to the need for more effective preventive programmes related to falls. Studies that assess long-term consequences of TBI in elderly patients are also needed.

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Introduction

Traumatic brain injury (TBI) is a worldwide public health problem, with a high mortality among the severest injuries and long-term loss of functioning even among persons with mild TBI [1, 2]. The incidence of TBI is difficult to assess as not all patients seek medical care, and complete registrations from primary health care are difficult to obtain. The number of hospital-admitted TBI patients is regarded as an important indicator of the impact of local injuries on hospital resources [1]. Several international epidemiological studies have reported changes during the last decade in the trends of TBI hospitalizations, incidence and mortality rate [3–6]. The age spectrum of TBI is also changing, with increasing incidence in the elderly [6–8]. Falls are the leading cause of TBI in Northern Europe [1, 7, 9, 10], and the same trend is found in recent studies in the USA [3, 5]. Traffic accidents continue to be the main cause of severe and fatal injuries [1, 4, 7].

The changes in injury mechanism during the last 10–15 years, along with wider availability of emergency medical services and specialized trauma systems may influence injury severity. More efficient and effective forms of evaluation and intervention during the acute stages of injury have resulted in decreased case fatality rates (CFR) and total mortality of TBI, shorter length of hospital stay and home discharge [2, 6, 8, 11]. Urban regions of residence have been suggested to be a protective factor for TBI in Australia [12].

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Mild TBI accounts for 80–90% of all head injuries, according to international studies [1, 8, 11, 13]. Some studies have shown that approximately 10–17% of in-patient admissions with initial mild TBI severity, as measured by the Glasgow Coma Scale (GCS), had intracranial lesions and that large numbers of these patients need rehabilitation after discharge from the acute hospital [14–16].

To implement more effective injury prevention and treatment programmes, it is important to identify the regional impact and trends of TBI [6]. Previous Norwegian studies on the TBI incidence were conducted between 15 and 30 years ago [9, 17, 18], and existing data from an urban area of East Norway are from 1974 [18]. The incidence of TBI hospitalizations has never been investigated in Oslo, and research is needed for current information about this population. Oslo is representative of big-city populations in Scandinavia in terms of the gender and age distribution in the population (sources: Statistics Norway, Denmark and Sweden, 2005), in addition to the urbanity of the region, availability of the emergency services and level I trauma centres.

The aim of this paper is to assess the annual incidence of hospital-treated TBI in Oslo and to describe the severity of injury, as well as the outcome of the patients' acute medical care.

Patients and Methods

Study Region

Ullevål University Hospital is located in Oslo, the capital of Norway. It is a Trauma Referral Centre with a population base of nearly 2.4 million people, and the Primary Trauma Hospital for 534,129 inhabitants in Oslo (260,731 males and 273,398 females). Most of the Oslo population live in urban areas and work in the civil service sectors. It is the largest urban population in Norway. Trends of incidence are easier to detect in this catchment population because all patients with TBI are referred to the same Trauma Hospital. This study is a part of a larger TBI project in East Norway, which has been approved for ethical aspects by the Norwegian National Committee for Medical Research Ethics. More in-depth analyses of project data regarding severity of TBI, risk factors of specific complications, interventions and functional outcome will be the focus of future articles.

Inclusion Procedure

This prospective population-based study comprises persons residing in Oslo at the time of injury, hospitalized with acute TBI, during the period from 15 May 2005 to 14 May 2006. We combined data from the electronic hospital admission register with a detailed review of medical records. This allows an accurate description of the incidence and severity of brain injuries.

The electronic patient register from the hospital emergency room was searched weekly to identify all patients admitted to the

hospital with acute TBI of any severity. TBI has been defined as 'damage to brain tissue caused by external mechanical force as evidenced by: loss of consciousness due to brain trauma, or post-traumatic amnesia, or skull fracture, or objective neurological findings that can be reasonably attributed to TBI on the initial physical or mental status examinations' [19].

The patients were selected and medical records were reviewed using the International Classification of Diseases, 10th edition (ICD-10). The following ICD-10 codes were used: S02.0–S02.9 (skull and facial fractures), S06.0–S06.9 (intracranial injuries), S07.0, S07.1, S07.8, S07.9 (crushing injury of head), S09.7–S09.9 (other and unspecified injuries of head), T04 (crushing injuries involving head with neck) and T06 (injuries of brain and cranial nerves). With respect to injury severity, the ICD-10 allows differentiation between contusions, intracranial haemorrhages and concussions. Patients were registered with the severest TBI diagnosis occurring to that patient during the stay at the hospital, with the following hierarchy: contusions/diffuse brain lesions (S06.1–S06.3, S06.7–S06.9, S07.0, S07.1, S09.7, T04.0 and T06.0), traumatic intracranial haemorrhages (S06.4–S06.6), cranial fractures (S02.0, S02.1 and S02.7–S02.9) and concussions (S06.0) [20].

The medical records of a total 1,816 admitted patients were reviewed. Thirty-nine percent of these admissions (717 patients) sustained mostly isolated injuries to the scalp, isolated facial and jaw fractures and these were excluded, as well as patients with anoxia and birth trauma; 1,099 patients with TBI were thus identified. Of those patients 41.3% did not live in Oslo, 13% had chronic subdural haematomas, 3.3% had multiple admissions for the same injury and 1.9% were admitted to the hospital later than 48 h after the trauma. The remaining 40.5% (445 patients) met the inclusion criteria. 440 of these patients were admitted within 24 h and 5 patients during the next 24 h. Of these 5 patients, 3 were admitted from local hospitals outside the Oslo region and 2 from their homes, as they deteriorated to a condition meeting the inclusion criteria of this study.

According to ICD-10, the external cause of injury was classified as transport accidents (irrespective of type), falls (irrespective of height), assaults and other causes [7]. Other causes also include sport accidents.

The initial severity of TBI was measured by the GCS score given on admission to the hospital or pre-intubation values assigned at the site of injury. GCS scores were not available for 19 patients. In these cases the authors assigned the scores according to information in the medical records expressing the level of consciousness on admission. TBI is classified as mild (GCS 13–15), moderate (GCS 9–12) and severe (GCS 3–8) according to the GCS score.

The ICD-10 diagnoses were in accordance with findings on computed tomography (CT) scanning performed on admission. This allows one to validate the ICD-10 codes of brain abnormality (i.e. brain contusion or haematoma). All the patients older than 15 years underwent a CT scan on admission. In 64 children, a CT scan was not undertaken. Most of these were very young children (0–4 years), and their injuries were assessed clinically to be mild and were coded as concussions.

Statistical Methods

The incidence of hospital-treated TBI per 100,000 population per year was calculated on the basis of the following information:

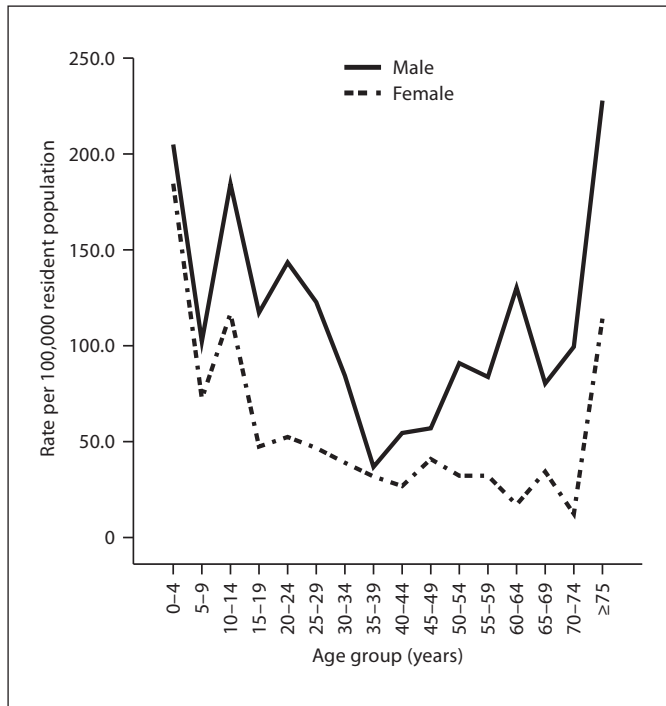


Fig. 1. Mean annual incidence of hospital-treated TBI by age and gender.

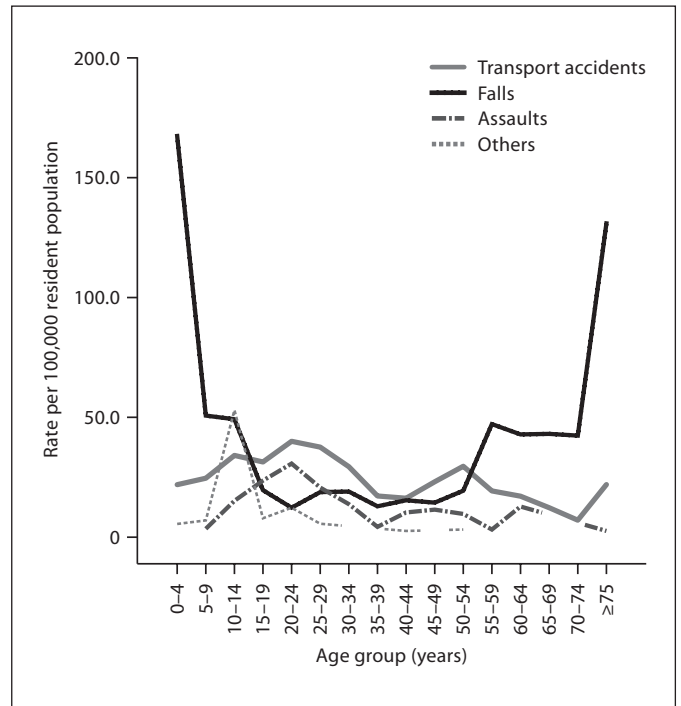


Fig. 2. Mean annual incidence of hospital-treated TBI by cause of injury.

- (1) the number of new hospital-treated cases with acute TBI residing in Oslo was used as the numerator;
- (2) information on the demographic data of the Oslo population from Statistics Norway, 2005 (534,129 inhabitants) was used as the denominator.

Data are presented by the median with interquartile range, i.e. the 25th and 75th percentile values or proportions. CFR were calculated using the following formula: $[\text{fatal injury}/(\text{fatal injury} + \text{non-fatal injury})] \times 100$. When comparing genders, the Mann-Whitney U test was used for continuous not normally distributed data. The χ^2 test for contingency tables was obtained to detect associations between categorical independent variables. Multiple linear regression analysis was performed to determine whether the association between length of hospital stay and GCS remained significant after adjusting for age, gender and associated injuries. The length of hospital stay was log-transformed when performing linear regression analyses, as this variable was skewed. A significance level of 5% was used ($p < 0.05$). All statistical analyses were performed with SPSS 15.0 (SPSS Inc., Chicago, Ill., USA).

Results

Incidence

During the study period, 445 patients fulfilled the inclusion criteria, 284 males (63.8%) and 161 females

(36.2%), 308 adults (range 16–93 years) and 137 children (range 0–15 years). The annual incidence of hospital-treated TBI for the residing population was 83.3/100,000. The median age and interquartile range of the population was 29 (11–53): 29 years (12–53) for males and 27 years (7–53) for females. Mann-Whitney analysis revealed no significant difference in the gender-specific age.

The annual incidence of TBI hospitalizations by age and gender is shown in figure 1. Age groups are defined according to Statistics Norway. The annual gender-specific incidence was 108.9/100,000 for males and 58.9/100,000 for females. The male:female ratio was 1.8:1.0. The age-specific incidence for males was highest in the elderly age groups (≥ 75 years) with 227.8/100,000 per year and lowest in the age group 35–39 years with 36.8/100,000 per year. In females the annual incidence was highest in the youngest group (0–4 years) with 184.5/100,000 and lowest in the age group 70–74 years with 12.3/100,000.

External Causes of Injury

Falls were the leading cause of TBI and occurred in 51% of patients, followed by transport accidents (29.7%),

Table 1. Percentage of level of severity by the GCS and by ICD-10 diagnoses

Severity category	Contusions	Intracranial haemorrhages	Cranial fractures	Concussions	Total GCS sample
GCS					
13–15 mild	27 (7.1)	20 (5.2)	39 (10.2)	297 (77.5)	383 (86)
9–12 moderate	14 (40.0)	14 (40.0)	1 (2.9)	6 (17.1)	35 (7.9)
3–8 severe	13 (48.1)	12 (44.4)	1 (3.7)	1 (3.7)	27 (6.1)
Total ICD-10 sample	54 (12.2)	46 (10.3)	41 (9.2)	304 (68.3)	445 (100)

Figures in parentheses are percentages.

assaults (12.8%) and other injuries (6.5%). The annual hospital-treated TBI incidence of falls was 42.5/100,000, followed by transport accidents 24.7/100,000, assaults 10.7/100,000 and other injuries 5.4/100,000.

External causes of injury varied with age, as shown in figure 2. The incidence of TBI hospitalization associated with falls showed 2 age peaks, one in the youngest and the other in the elderly age groups. The highest incidence of transport accidents was in the age groups 20–29 years; transport accidents were the most common cause of TBI in age groups 15–39 years. The incidence of assaults was highest in the age group 20–24 years, and the peak of other injuries was in the age group 10–14 years.

Males had higher injury rates than females in all age groups. The highest male:female ratio was in injuries caused by assaults (6.1:1) and the lowest in other injuries (1.2:1).

Severity of TBI

The majority of patients hospitalized with TBI were classified as mild cases (86%) according to the GCS. χ^2 analysis revealed no gender differences in severity of injury as measured by GCS. Severity of injury is summarized in table 1. Contusions and intracranial haemorrhages were found in 47 patients (12.3%) in the group with mild TBI. Seventy-seven percent of patients had a diagnosis of concussions in this group. Conversely, in the group of severe TBI, concussion only occurred in 1 case. One third of patients classified as having mild TBI were in the age group 0–14 years. In the moderate TBI group about half the patients were older than 60 years. The median age in the group with severe TBI was 43 years with one quarter of patients in the age group ≥ 75 years.

Figure 3 presents the distribution of ICD-10 diagnoses across all age groups. Contusions and intracranial haemorrhages were most often found in the elderly age group

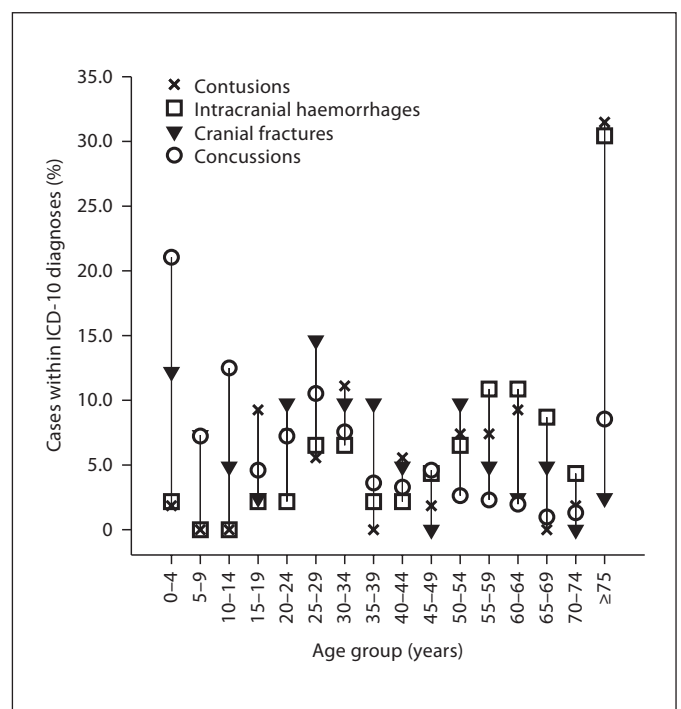


Fig. 3. The distribution of ICD-10 diagnoses across age groups (n = 445).

(≥ 75 years); intracranial haemorrhages were most common in patients over 55 years. Cranial fractures and concussions were the most often met diagnoses in the age groups 20–54 years. One third of all concussions were found in children (0–14 years).

The median age in the group with concussions was 22 years, with contusions 53.5 years, and with intracranial haemorrhages 60.5 years. Intracranial lesions were more often observed in falls [$\chi^2(9) = 17.6, p = 0.04$].

Table 2. Percentage of discharged patients by the GCS and discharge place

Discharge place	GCS 13–15 n	GCS 3–12 n	Total sample n	Rate per 100,000
Home	312 (81.9)	15 (27.3)	327 (75.0)	61.2
Local care hospitals	35 (9.2)	36 (65.5)	71 (16.3)	20.4
Nursing homes	11 (2.9)	4 (7.3)	15 (3.4)	2.8
Another care facility	23 (6.0)	0 (0.0)	23 (4.3)	4.3

Figures in parentheses are percentages.

Case Fatality Rate

Nine patients died after admission to the hospital; hence the in-hospital CFR was 2.0/100 hospitalized patients. The proportion of fatal outcome was highest in the group with severe TBI (18.5%) compared with the moderate (5.7%) and mild TBI groups (0.5%). Two thirds of the deceased patients were in the age group ≥ 80 years.

Length of Hospital Stay

The length of hospital stay ranged from 1 to 52 days with 64.7% of the patients admitted to the hospital for 24-hour observation and 5% hospitalized for more than 10 days. The median duration of hospital stay was 1 day (range 1–2), increasing significantly with severity of TBI: mild 1 day (1–2), moderate 3 days (2–10) and severe 9 days (3–18); $\beta = 0.73$, $p < 0.001$, 95% CI = 0.62–0.84, when adjusting for age, gender and TBI with associated injuries. Elderly patients (age group ≥ 75 years) had longer hospitalization than the others, with $\beta = 0.3$, $p < 0.01$, 95% CI = 0.07–0.5. Mann-Whitney analysis revealed no significant gender difference regarding the length of hospital stay.

Discharge Place

Three quarters of the population were discharged to their home, as shown in table 2. The proportion of discharged patients to local care/in-patient rehabilitation facilities increased significantly with severity of injury, from 18.1% for those with mild TBI to 72.8% for moderate/severe TBI [$\chi^2(3) = 118.6$, $p = 0.001$]. Three quarters of all the elderly patients (≥ 75 years) were discharged to the local care facility. Of the 69 patients with mild TBI who required local care/in-patient rehabilitation facilities, 42% were elderly (≥ 75 years), and half of them suffered from concussions. Intracranial lesions occurred in 30.4% of the mild TBI patients in need of health care facilities. χ^2 analysis revealed a significant gender difference in discharge place, as more females were discharged to nursing homes and other care facilities [$\chi^2(3) = 10.7$, $p = 0.01$].

Discussion

Incidence

As previously reported, we estimated the annual incidence of hospital-treated patients with acute TBI in Oslo to be 83.3/100,000. This is considerably lower than rates reported in previous population-based studies in Scandinavia and North Europe [9, 17, 18, 21–24]. In 3 Norwegian regional studies based on hospital-treated TBI, the incidence has fallen from 236/100,000 in 1974 to 200/100,000 in 1979–1980, and again to 169/100,000 in 1993 [9, 17, 18]. The same pattern of decline in TBI incidence was also found in a national study in Denmark over the same time period: 265/100,000 in 1979–1981 to 157/100,000 in 1991–1993 [21]. Furthermore, a national study in Finland only enrolled patients who were registered for the first time in the Hospital Discharge Register, thus reporting a substantially lower incidence of 95–100/100,000 in 1991–1995 [24]. However, a national study in Sweden using the Hospital Discharge Register showed a stable hospital discharge incidence, on average 259/100,000 in 1987–2000 [23]. In other European countries, the incidence of hospital-treated TBI in regional populations ranged from 91/100,000 in Spain in 1988 [25] to 365/100,000 in Sweden in 1992–1993 [22]. The study from Spain used comparable inclusion criteria and reported an incidence similar to that of the present study. Similarly, a recent published report from the USA [3] estimated the average incidence rate of hospitalization related to TBI in 12 states to be 79/100,000 (range 50.6–96.9) in 2002.

Variation observed in the incidence of TBI hospitalizations in different countries could be partially explained by differences in criteria used to define TBI or to identify patients [1, 7, 9, 21]. According to Jennett [1], higher incidences are reported in studies identifying TBI cases by hospital admissions, by discharge registers or by routine ICD coding, than in studies reviewing medical case records. The former studies could be biased because of dou-

ble counting of patients with multiple hospital admissions, and also by the inclusion of late admissions with delayed complications [1]. Hospital admission policies and access to health care systems also vary within and between countries [1, 7, 9, 21].

Incidence calculation in our study may have been limited by several factors. Our data provide no information about the number of persons with acute TBI treated in local emergency departments or other out-patient facilities, and persons who did not seek medical care. Oslo-residing patients sustaining milder injuries outside their home region, and not treated in Ullevål University Hospital, could not be identified. However, the number of patients included in our study is in accordance with information on hospital-treated Oslo-residing persons with traumatic intracranial injuries in Oslo hospitals in 2005 (source: Statistics Norway).

These results indicate a trend towards a decreasing incidence of hospital-treated TBI in Norway, perhaps due to the effectiveness of preventive traffic accident legislation, as reported in other European countries, with a subsequent decrease in road traffic accidents [4, 9, 23, 26]. The density of road traffic in Norway has increased substantially over the last 10 years, but the risk of injuries and death in road traffic accidents has declined from 0.400 to 0.288 per million vehicle kilometres for the same period of time [27]. Our findings may also indicate changes in hospital TBI admission practices, hopefully due to the implementation of guidelines for the initial management of minimal, mild and moderate head injury in Scandinavia [28], as well as for guidelines for severe TBI [29], and also in the decrease in TBI mortality rates in Norway during the last 10–15 years [30].

Age and Gender

The present study shows a bimodal age distribution as the elderly and the youngest children are most often affected by TBI. This supports the findings of previous studies; the most common populations affected by TBI are children aged 0–4 years and adults over 75 years [2, 5, 8, 11]. The large number of TBIs in the elderly could be associated with the trend of ageing in the population [5, 11]. In contrast to previous Norwegian and international studies, we found a lower incidence in the age groups 15–29 years, probably due to a decline in transport-accident-related TBI incidence as previously pointed out. In this study, the incidence was highest among males, a finding reported both in national and international studies [7, 9, 18, 23, 25].

External Cause of Injury

Falls comprise the most common cause of TBI-related hospitalization in all groups of severity in this study, followed by transport accidents and assaults. The increase in falls, as the most frequent cause of TBI, is consistent with a previous study from Norway [9] and recent reports from the USA [3, 5, 6]. Transport accidents as a cause of TBI decreased in Norway from 58% in 1974 [17] to 21% in 1993 [9] in accordance with several international studies. Studies from the USA [3, 8], Europe [4, 7, 31] and Scandinavia [20, 23] published since the 1990s show the same trend in the TBI injury mechanisms. The proportion of TBIs related to transport accidents varies widely in epidemiological studies, ranging from 16% in Western Sweden [22] to 60% in Spain [25]. The incidence of transport-accident-related TBI is considerably lower in our study than in other European studies [7] but agrees with rates reported in a recent US study [3]. These findings may reflect the effectiveness of preventive efforts that have been introduced during the last 10–15 years, such as better road standards, safer cars, speed and blood alcohol concentration limits, use of helmets and safety belts and a new driving education programme in Norway, as well as different health campaigns and programmes against the use of drugs and alcohol [9, 20, 22, 26, 27, 31]. Age-related transport accidents as a cause of TBI were highest in young men aged 20–29 years, and that appeared to be similar, with slight age variation, to that reported in other studies in Europe [7] and the USA [3, 5]. However, transport accidents were found to be more frequent among young women aged 20–29 years in Finland [24]. The incidence of transport accidents falls with advancing age in this study; however, a smaller rise was observed in the elderly over 75 years, half these patients were injured as pedestrians, thus demonstrating their problems associated with slower reaction time [21], mobility and sensory deficits [11].

Falls accounted equally for the TBIs among the youngest age (0–4 years) and among the elderly (≥ 75 years), 86% in each group. Sensory deficits, muscle weakness, co-morbid conditions and use of medication, greater unsteadiness and greater frequency of orthostatic hypotension and arrhythmia may contribute to the higher risk of falls in the older patients [11]. A high mobility and orientation problems in the youngest children increase the risk of falling in this group [17]. Proper fall prevention strategies are needed, such as advice to the families of infants and young children about environmental in- and outdoor hazards as well as environmental adaptations. Prevention strategies related to the environment are also

needed for the elderly, as well as training programmes and technical facilities for those with sensory deficits and muscle weakness [11]. In addition, proper medication management and treatment of co-morbid conditions will probably reduce the incidence of falls in the elderly. Welfare programmes and a multidisciplinary approach to this type of problem in the elderly should be considered.

The incidence of assaults is higher in this study than in Northern Norway [9] and US studies [3, 6], but a similar incidence is found in Europe [7] and Sweden [23]. However, assaults were a less common cause of TBI in Spain [25]. In our study, alcohol influence was found in as many as 82% of victims of assaults. Other injuries/sport injuries are uncommon in the study population, with the highest incidence in the adolescents, both boys and girls, probably due to their greater exposure to risky situations in play activities [17].

Severity of TBI

The proportion of TBI severity as measured by the GCS in the present study agrees with the findings in other studies [1, 7, 13]. The largest proportion of cases were classified as mild TBI, according to GCS scores (86%). A study from Spain [25] reported 88% of cases suffering from mild TBI. Mild TBI, as determined by acute severity measures, is not always associated with mild consequences. Biases of severity classification by the GCS were most frequent in the milder injuries in this study. Twelve percent of these patients had contusions and intracranial haemorrhage and 10% suffered skull fractures. These results support previous international findings [14, 16]. Williams et al. [14] found that persons with GCS scores of 13–15, and positive findings on a CT scan, had a course of recovery similar to that of persons with moderate TBI, but a worse outcome compared to those with similar GCS scores without CT findings. From the present study, it can be expected that 12.3% of patients with mild TBI as measured by ICD-10, 80% of patients suffering from moderate and 92.5% of those with severe TBI will have long-term loss of functioning. This underlines the need for a close observation of mild TBI patients in the acute stage as well, and a follow-up and rehabilitation intervention after acute treatment.

With regard to age-related TBI severity, as measured by ICD-10, the proportion of concussions was highest in the children (0–14 years) accounting for 90%, with an incidence of 136/100,000. Contusions and intracranial haemorrhages were most common in the elderly (≥ 75 years) with incidences of 44.5/100,000 and 36.6/100,000, respectively. A study from Denmark [21] showed that the

age-specific and severity-related incidence for younger patients decreased substantially; however, the rates were constant or slightly increased in older patients for the period from 1979–1981 to 1991–1993. A peak incidence was also reported for concussions in the age group 0–14 years (231/100,000) and for structural brain injury for the age group ≥ 60 years (42/100,000 for males) in 1991–1993. Our results support this finding of a severity trend observed in the elderly.

Case Fatality Rate

As reported in the literature, the overall rate of TBI mortality has declined since the 1990s [7, 11, 26, 30]. Various factors may contribute to this decline, for example reduction in both motor-vehicle- and assault-related deaths, greater use of seat belts as well as improved emergency and acute trauma services [26, 29]. Recent studies confirm that the creation of a regional trauma referral system (level I trauma centre) has resulted in significant reductions in mortality and morbidity in trauma victims in general, and in traumatic head injury victims in particular [13, 29, 31]. A study from the University of Texas Medical Centre documented a major drop in the CFR in trauma patients with severe injuries from 1986 to 1995, as cited by Kelly and Becker [29]. However, the age distribution shows an increase in the absolute number of fatal injuries with advancing age, most of them caused by falls [11, 26].

The average CFR in our study was low, mostly related to falls in severely injured and elderly patients, but also to an increased number of medical complications in these patients. Many studies in Europe [1, 7, 17, 18, 25], as well as from Australia [7], have shown that the CFR has been stable over the last years. The CFR in the present study is consistent with these rates. Deaths prior to hospitalization were not accounted for in the present study. In-hospital mortality has been shown to account for one third of total deaths from TBI [1, 26, 31]; thus, the overall mortality in Oslo can be estimated to be 5.0/100,000 inhabitants. This is slightly lower than both another Norwegian study from Oslo's surrounding county, with 6.6/100,000 [7, 18], and the urban mortality rate in Australia, with 6.4/100,000 [12]. Our estimated rate for overall mortality is slightly higher than the rates from Western Sweden, 4.0/100,000 [22]. However, this rate is considerably lower than the median mortality rate in Scandinavia (11.5/100,000) and in Norway (10.5/100,000), estimated for the period 1987–2000 [30]. It is possible that mortality rates in Oslo are lower than in other areas of Norway. Oslo is an urban region with wide availability of emer-

gency medical services and level I trauma centres, and with the lowest mortality from transport accidents in the country (source: Statistics Norway, 2005).

Length of Hospital Stay and Discharge Place

The length of hospital stay and discharge place were both closely related to injury severity. Admission for 24-hour observation was most common in this population. A previous Norwegian study from 1993 showed similar findings for the length of hospital stay [9]. It seems that the practice of hospitalization for 24 h for milder injuries has not changed over the last 15 years even though patients were screened by a CT scan. The same trend of practice is reported in Germany [26]. Some of these patients could be treated as out-patients if guidelines for initial management of minimal, mild and moderate head injury are followed as recommended [28]. As expected, the median duration of hospital stay was highest for severe TBI. Elderly patients in the age group ≥ 75 years had the longest hospitalization, as found in several international studies [3, 5, 8, 23]. The present study was undertaken to describe the outcome by the time of hospital discharge from acute medical care. A large number of patients were discharged to their homes as reported in other studies [3, 6, 31]. Twenty-five percent of the population and 18% within the milder injuries were discharged to local care hospitals, nursing homes and other care facilities. The follow-up health care of the patients in the present study is more a consequence of their TBI condition itself rather than of TBI with additional injuries. Additional injuries were diagnosed in only one quarter of all hospital discharges to local care facilities and one fifth of those with mild TBI. Social factors may have influenced the length of stay and discharge place in the elderly patients with mild TBI in this study, as reported by Jennett [1]. Half these patients were coded as concussions without additional injuries. A higher proportion of elderly females were discharged to local care facilities. Elderly females are probably more vulnerable, perhaps because of

a lack of home support and a feeling of insecurity after injury. In the Norwegian population, 60% of those in the age group ≥ 80 years live alone, 14% live in nursing homes, and there are twice as many females as males in this group [32].

Conclusion

The study results show a low incidence of hospital-treated TBI. Falls were considered the most common external cause of TBI and the great majority of patients are hospitalized with mild TBI. The most common cause of mild TBI was concussions in children. The elderly were more often found to have intracranial lesions.

These findings may indicate that more effective prevention programmes are needed to focus on high-risk populations as regards falls in both the youngest and the elderly, as well as transport accidents in younger adults. Multidisciplinary in-patient treatment and rehabilitation, and out-patient follow-up programmes are also needed in order to accommodate for the complexity of TBI disabilities. A higher number of elderly TBI patients will require acute care and rehabilitation services in the future, as the population is ageing. There is a need for further studies on the causes of TBI and long-term outcome in elderly TBI patients (at all levels of severity) in order to obtain a better understanding of their disabilities and health care problems. Such information would be helpful for planning appropriate services for these patients in the future.

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