

Head Injuries among Children: Patients Admitted to Three Hospitals in Reykjavik during the years 1987-1991

J.G. Halldórsson¹, E.Ö. Arnarson² and K. Guðmundsson³

¹The State Diagnostic and Counselling Center for the Handicapped, Kopavogur, Iceland, ²Department of Psychiatry, National University Hospital, Reykjavik, Iceland, ³Department of Neurosurgery, Reykjavik City Hospital, Iceland.

Abstract: The incidence of brain injury (ICD 850-854) among 0-14 years old children in the Reykjavik area was studied over a five year period 1987-1991. On average 72 brain injured children were admitted to hospital each year, an annual incidence rate of 170 per population of 100 000. Children younger than 15 years of age were 41% of all individuals sustaining brain injury. The age group 5-9 years old was the largest of all age groups, children and adults alike, followed by the youngest age group 0-4 years old. Fourteen percent of children received the more severe forms of brain injury (ICD 851-854), an annual incidence rate of 28 per 100 000. Seven Icelandic children died from brain injury, indicating an annual death rate of three per 100 000. Six of these children were younger than 10 years of age. Results indicated a decrease in the incidence of childhood brain injuries in the Reykjavik area during the last two decades. The greatest reduction in number of admissions was found in the 5-9 year age group, but little change was observed in the youngest age group. While there was a general decline in severe brain injuries, a proportionally high percentage of the youngest age group was suffering from severe brain injuries. On average 1-2 children were referred for rehabilitation each year.

Head trauma is a major cause of morbidity and mortality in children and adults in the western world (1). In the USA it is estimated that the annual incidence rate of brain injury among children is 200-300 per population of 100 000, and approximately 10% of these are severe injuries. It is estimated that ten children per 100 000 die each year of brain trauma (2).

Guðmundsson (3) studied brain injury in the Reykjavik area during a seven year period 1973-1980. Of the 1435 patients admitted to the Neurosurgical Ward of the Reykjavik City Hospital with brain injury (ICD 850-854), there were 673 (47%) children 14 years or younger, on average 84 children each year, indicating an annual incidence rate of 200 per population of 100 000. Sixty four percent of the children were boys. Traffic accidents resulted in 164 (24%) of the injuries. Children aged between 5-9 years suffered head injury most often. Children in that age group were 295 (44%). Twenty four percent of the children were aged 0-4 years, and 32% were 10-14 years. Twenty percent (134) of the children were admitted to the Intensive Care Unit of the City Hospital with severe head injuries, mostly as a result of traffic accidents (63%), nine of whom died and five suffered serious physical and mental sequelae. The long term sequelae are unknown, except for the 14 children who either died or had been seriously impaired.

Guðmundsson's study (3) provides information regarding the incidence of pediatric brain injury in the Reykjavik area in the seventies. The rapid changes in Iceland over the past decade, for example with regard to greater number of motor vehicles and heavier traffic, as well as the recently increased emphasis on preventive measures, kindled interest in looking at changes in the incidence of brain injury. The present study also provides a basis for a prospective, longitudinal neuropsychological study on the severity and sequelae of brain injury in childhood and adolescence presently being carried out at the Reykjavik City Hospital.

The Emergency Unit (EU) at the Reykjavik City Hospital serves the Reykjavik area. A majority of individuals in the area suffering brain injury, mild, moderate or severe, initially come to the EU for medical evaluation and treatment. Individuals with severe brain injuries from rural Iceland are brought to the Reykjavik City Hospital as it is equipped with the only neurosurgical unit on the island. Patients outside the Reykjavik area, suffering less severe forms of brain injury, are treated at local hospitals.

A majority of children in the Reykjavik area suffering brain injuries are also brought to the EU of the Reykjavik City Hospital and may be admitted to the Neurosurgical Ward for further diagnosis, treatment, and care. If neurosurgery is not required and when medically stable, children are in some cases trans-

ferred to the pediatric wards of the National University Hospital or Landakot Hospital in Reykjavik. Brain injured children may also be admitted directly to the pediatric wards.

Most of the rehabilitation services for brain impaired patients in Iceland are concentrated in the Reykjavik area. Children needing rehabilitation following brain injury are treated at the pediatric ward of the National University Hospital. Further rehabilitation resources are available at Reykjalundur, a rehabilitation centre about 15 km out of Reykjavik. The emphasis is on physical rehabilitation.

Material and methods

The present study includes all 359 new occurrences of brain injury (ICD 850-854) among children aged 0-14 years admitted to the Reykjavik City Hospital and to the pediatric wards of the National University Hospital and Landakot Hospital during the five year period 1987-1991. Data regarding the total number of children admitted and the incidence of brain injury, by age and by sex, were gathered through hospital archives (4). Severity of brain injury was estimated by medical diagnosis according to the International Classification of Diseases, Ninth Edition (ICD9) (5). The ICD codes 851-854 indicate the severe injuries, while ICD 850, concussion, denotes a relatively milder form of brain injury. ICD 851 refers to cerebral laceration and contusion; ICD 852 subarachnoid, subdural and extradural hemorrhage following injury; ICD 853 other and unspecified intracranial hemorrhage following injury; and ICD 854 intracranial injury of other unspecified nature.

Information was gathered regarding number of brain injured children receiving rehabilitation during the period 1987-1991, by looking at length of hospitalization and by counting the number of children referred for rehabilitation at the rehabilitation centers in and around Reykjavik.

Results

During the five year period 1987-1991, 886 patients were admitted to the Neurosurgical Ward of the

Reykjavik City Hospital and to the pediatric wards of the National University Hospital and Landakot Hospital, diagnosed with brain injury (ICD 850-854). Children 0-14 years old were 359 (41%), on average 72 each year, indicating an annual incidence rate of 170 per population of 100 000 in the Reykjavik area. Table I shows number of children by age, by sex, and by ICD number. The age group 5-9 years old was the largest of all age groups, children and adults alike, followed by the youngest age group 0-4 years old. Fourteen percent of the children received the more severe forms of brain injury, ICD diagnoses 851-854. The annual incidence of severe brain injury comes to 28 per 100 000.

During the five year period, seven Icelandic children died from brain injury (ICD 850-854), indicating an annual death rate of 3 per 100 000. Six of these children were younger than ten years of age, and five were girls.

On average, 59 brain injured children were admitted to the Neurosurgical Ward of the Reykjavik City Hospital each of the five years. Only 6% of these children were admitted to the Intensive Care Unit. Forty four percent of the brain injured children admitted to the City Hospital were 5-9 years, 27% were 0-4 years, and 32% were 10-14 years old.

A majority (58%) of the brain injured children admitted to the pediatric wards of the National University Hospital and the Landakot Hospital were 0-4 years old.

Judging from hospital records, on average 1-2 severely brain injured children received rehabilitation each year.

Discussion

A recent study at the Emergency Unit (EU) of Reykjavik City Hospital (6) indicates that during the years 1974- 1991 the annual incidence rate of accidents among children aged 0-14 years living in Reykjavik was 299 per 1000; 345 per 1000 among boys and 250 per 1000 among girls. The study indicates a reduction in the incidence of accidents among children. An incidence rate of 264 per 1000 in 1991 is,

Table I. Number of brain injured children 0-14 years old, by age, by sex, and by ICD number, admitted to three hospitals in Reykjavik 1987-1991.

Diagnosis (ICD)	Age						Total	%
	0-4 years		5-9 years		10-14 years			
	Boys	Girls	Boys	Girls	Boys	Girls		
Concussion/Comotio Cerebri (850)	60	38	69	56	58	28	309	86
Cerebral Laceration/Contusion (851)	2	3	8	1	6	1	21	5
Hemorrhage in Cerebral Meninges (852)	6	1	3	2	3	2	17	5
Other Intracranial Hemorrhage (853)	3	1	1	0	1	0	6	2
Other Intracranial Injury (854)	1	1	0	0	3	1	6	2
Total(%)	72(20)	44(12)	81(23)	59(16)	71(20)	32(9)	359	100

however, still high compared to Scandinavian countries such as Norway (7) and Sweden (8) (see Table II). The incidence of brain and spinal injuries diagnosed among children at the EU, however, was not found to be higher than that reported in Sweden (8) and France (9) (see Table II).

During 1987-1991 on average 412 children less than 15 years old were diagnosed annually with brain or spinal injuries at the EU of the City Hospital (4). This gives an annual incidence rate of 11 per 1000. The highest incidence was found in the youngest age group. On average 201 children (49%) aged 0-4 years were diagnosed with brain or spinal injury resulting in an annual incidence rate of 17 per 1000 for that age group.

Fewer children less than 15 years old were hospitalized because of brain injury (ICD 850-854) each year during 1987-1991 than 1973-1980. Comparing results from the Reykjavik City Hospital, the annual average decreased from 84 to 59, and the annual incidence rate from 200 per 100 000 to 140 per 100 000. The decrease is greatest in the 5-9 years age group, but least in the youngest age group. In the age group 5-9 years the incidence of brain injury is still highest.

The percentage of children among hospitalized brain injured individuals in Reykjavik has decreased from 47% during 1973-1980 to 41% during 1987-1991. This percentage is still high compared to results from other countries (1,10,11).

Table II compares the results of studies from seven countries on the incidence of pediatric brain injuries to the results of the present study. As indicated in Table II, the annual incidence rate of

hospitalizations due to brain injury (ICD 850-854), the incidence of severe brain injury, and the annual incidence rate of deaths due to brain injury reported in the present study, is similar to what has been found in other countries.

Methodological problems make it difficult to compare incidence of brain injury between sites. This is e.g. due to differences in definitions and differences in the organization of health care. Results of the present study indicate, however, that Icelandic children run a similar risk as children in the USA (1) and in Israel (12) to suffer brain injury. The incidence of children hospitalized due to brain injury is lower in Iceland than in the neighbouring Scandinavian countries Norway (10) and Sweden (11).

The sex ratio in the present study, 37% girls and 63% boys, is comparable to previous studies on pediatric brain injury in Iceland and other countries (1,3). Twenty six percent of children suffering the more severe forms of brain injury (ICD 851-854) were girls. However, more girls than boys died from brain injury during the period.

Only 6% of the children were admitted to the Intensive Care Unit of the Reykjavik City Hospital during the five year period 1987-1991, compared to 20% 1973-1980. These results together with ICD diagnoses indicate a reduction in the incidence of severe brain injuries among children. The relatively high percentage of children in the youngest age group with severe injuries is however of concern (see Table I).

On average 1-2 children were referred for rehabilitation each year. Rehabilitation was reserved for

Table II. Results from studies in seven countries and from the present study regarding the incidence of brain injury among children.

	Annual incidence rate per population of 1000				
	Injuries at EUs	Brain and spinal injuries at EUs	Brain injuries admitted to hospital	Severe brain injuries	Death due to brain injury
Reykjavik 1973-1980	299 ¹⁾		2,00 ²⁾	0,40 ²⁾	0,03 ²⁾
Iceland 1987-1991	264 ³⁾	11,0 ⁴⁾	1,70 ⁴⁾	0,28 ⁴⁾	0,03 ⁴⁾
USA		1,85 ⁵⁾	0,27 ⁵⁾	0,10 ⁵⁾	
Israel		1,71 ⁶⁾	0,26 ⁶⁾	0,03 ⁶⁾	
Norway	125 ⁷⁾		2,34 ⁸⁾		
Sweden	143 ⁹⁾	9,8 ⁹⁾	2,62 ¹⁰⁾		
France		11,7 ¹¹⁾			
Denmark				0,30 ¹²⁾	

Reference within brackets

- | | |
|---|----------------------------|
| 1) (6) Reykjavik City Hospital, Emergency Unit 1974-1991. | 7) (7) Norway 1992. |
| 2) (3) Reykjavik City Hospital, Neurosurgical Ward 1973-1980. | 8) (10) Norway 1989. |
| 3) (6) Reykjavik City Hospital, Emergency Unit 1991. | 9) (8) Göteborg 1975-1976. |
| 4) Results of the present study. | 10) (11) Sweden 1988. |
| 5) (1) San Diego County 1981. | 11) (9) France 1981. |
| 6) (12) Israel 1970-1976. | 12) (13) Denmark 1990. |

children who had suffered the most severe injuries and showed signs of serious physical and mental deficits. The National University Hospital and Reykjalundur provided the rehabilitation services.

Study conducted in Denmark (13) indicates that a considerably greater number of brain injured children might be in need of support and rehabilitation due to mental and cognitive deficits than receive such services in Iceland at the present. The situation in Iceland in this regard is not known. However, a study now under way at the Neurosurgical Ward of the Reykjavik City Hospital, will address this issue.

Is the reduction in admissions found in the present study due to a reduction in head injuries among children or have the criteria for admission changed? Although changes towards stricter criteria regarding admission to hospital may account for some of the observed changes, the present study indicates both a reduction in head injuries among children leading to hospital admission, and a reduction in severe injuries, at least in the Reykjavik area. This decrease is probably due to greater emphasis on preventive measures which have been adopted in recent years, e.g. the increased use of child restraints in cars, protective helmets, and high visibility sashes or spacers for pedal cyclists. Information campaigns aimed at educating parents, children, and drivers, have also had effects. These preventive measures seem to have been especially effective in reducing the incidence of brain injury among older children. However, relatively high incidence of head injury among young children 0-4 years is of particular concern. Brain injury is still a far too common cause of morbidity and mortality among children. Further development of preventive measures is therefore of utmost importance. The results of the present study indicate the need for a special effort to prevent brain injuries among young children.

References

1. Kraus JF, Fife D, Cox P, Ramstein K, Conroy C. Incidence, severity, and external causes of pediatric brain injury. *Am J Dis Child* 1986; 140: 687-93.
2. Annegers F. The epidemiology of head trauma in children. In: Shapiro I, ed. *Pediatric head trauma*. Mount Kisco, New York: Futura Publishing Co, 1983: 1-10.

3. Gudmundsson K. Head injuries among children: Patients admitted to the Reykjavik City Hospital during the years 1973-1980. *Icelandic Health Records, Suppl.* 1986; 1: 43-7.
4. Information from the records of the Reykjavik City Hospital, the National University Hospital and the Landakot Hospital 1993.
5. World Health Organization. *The International Classification of Diseases (Ninth revision)*. Geneva 1977.
6. Stefansdóttir A, Mogensen B, Richter I, Sigvaldason H, Sigfósson R. Accidents among children: An epidemiological investigation in Reykjavik during the years 1974-1991. *The Icelandic Medical Journal, Suppl.* 1992; 22: 37.
7. Guldvog B, Thorgersen A, Ueland Ø. Ulykker, vold og selvpåført skade. Rapport nr. 1/1992. Statens Institutt for folkehelse, Oslo.
8. Nathorst Westfelt JÅR. Environmental factors in childhood accidents: A prospective study in Göteborg, Sweden. *Acta Paediatr Scand* 1982. Suppl. 291.
9. Davidson F, Magnus P. Les accidents chez l'enfant: Etude épidémiologique d'une zone rurale et d'une zone urban. *Archives Francaises de Pédiatrie* 1984; 4: 67-72.
10. Nasjonale pasientdata 1989, Norsk Institutt for Sykehusforskning, SINTEF, Trondheim.
11. Slutenvårdsregisteret 1988. Sosialstyrelsen, Stockholm.
12. Horowitz I, Costeff H, Sadan N, Abraham E, Geyer S, Najenson T. Childhood head injuries in Israel: epidemiology and outcome. *Int Rehabil Med* 1983; 5: 32-6.
13. Danish Countrywide Hospital Registration System 1986 (Landspatientregisteret). In: Engberg Aa, Biering-Sørensen F. Forekomst av traumatisk hjerneskade i Danmark, belyst av sykehusstatistikk. *Ugetidsskrift for Læger* 1990; 153: 16-21.

Correspondence:

Jónas G. Halldórsson

The State Diagnostic and Counselling Center

Digranesvegur 5, 200 Kopavogur, Iceland

Telefax: 354 1 64 17 53

Telephone: 354 1 64 17 44