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Analysis of 551 Head Injured Children

Chai-Ling Chen May-Ken Wong and Yun-Lan Chang*

To investigate the nature of exposure factors, and effectiveness of countermeasures in head injuries in Taiwanese children with head injuries consecutively admitted to Chang Gung Memorial Hospital from Jan. 1985 to Dec. 1989. We analyzed the data by chart review. The analysis confirmed a boy to girl ratio of about 2.3 to 1. The largest number of head injuries was in children under 1 year, 4 to 5 years and more than 15 years of age. The most common place for head injuries to occur was outdoors, with the road contributing the most, while the bedroom was the most common site for indoor injuries to occur. The most common cause of pediatric head injury was traffic accident (65%), of which most were hit by automobiles and motorcycles (59%). The next most common was falls (30%). Injuries were most common in summer (from May to August) and clustered at 3:00-5:00 pm. Most children suffered from mild head injury (77.86%), but there were still 122 children with severe head injury (22.14%). Of the 25.23% of children with skull fracture, most had linear type. Fractures of clavicle and long bone were the most common concomitant skeletal fractures. The frontal, temporal and parietal accounted for the most focal sites of injury on computer tomogram in that order. Brain surgery was necessary in 19.60% of children. Fifty children (9.07%) were either discharged in a critical condition or died in hospital.

Key words: Head injury, brain injury, child, epidemiology, trauma

INTRODUCTION

Accidents in general, and head injuries in particular, are among the major causes of mortality and morbidity in childhood (1-7). Mayer and colleagues estimated that about 75% of children died during hospitalization for significant brain injury (8). Head injury is the most common form of trauma for which children are admitted to hospitals (7,9). The incidence rate of brain injury is around 200 to 300 per 100,000 population (8,9). The overall risk of traumatic brain injury in children was estimated at 4% in boys and 2.5% in girls (1). In

the United States, the estimated number of children who required hospital admission was around 200,000 cases/yr; of these, about 15,000 required a prolonged stay (1,10).

Head injury is a major worldwide threat to health and life in childhood (1,3). If a child or young adult survives a moderate or severe brain injury, there is a strong likelihood of a lifetime of physical and mental impairment as well as tremendous economic and social impact on the family (1). Therefore prevention is the best solution for pediatric head injury. Based on our investigation of the nature of head injuries, exposure factors, and ef-

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fectiveness of countermeasures in the children of Taiwan, herein we seek to summarize certain basic epidemiological data and hope to find the most effective preventive measures for Taiwan.

MATERIALS AND METHODS

We reviewed the records of 551 children aged less than 15 years, who had been admitted to the Chang Gung Memorial Hospital for treatment or observation following head injury from Jan. 1, 1985 to Dec. 31, 1989. Those who had been injured by birth trauma were excluded from our study.

The severity of head injury was measured by the Glasgow Coma Scale (GCS), those persons with a GCS of 8 or less for at least 6 hours were considered to have severe injuries and the remainder were considered mild head injuries (11,12). The classification of head injury was dependent on three variables: GCS, diagnosis on computer tomogram and the length of coma (12,13).

The age, sex, the cause of head injury, onset time, arrival time, GCS, the duration of hospitalization, the visit type, the associated injuries, the type of skull fractures, the findings on the computer tomogram (CT), the severity of head injury, the type of brain or other surgery and mortality were all obtained from charts (11).

RESULTS

Gender and Age

The sex ratio of male to female was 2.3 to 1. For all age groups, there were more brain injuries for males compared with females (Fig.1). The age-specific admission rates showed there was an abrupt rise for those under 1 year old, 4-5 years old and 14-15 years old among the total and male populations, but only slight change in the female population (Fig. 1).

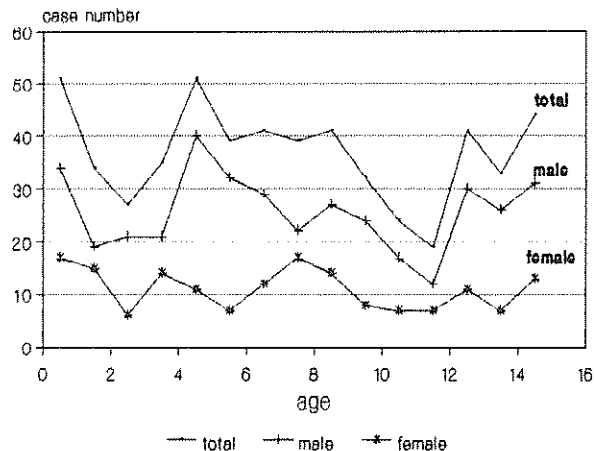


Fig.1 Age and Sex Distribution

Cause and Site of Injury

The causes of pediatric brain injuries were traffic accidents (65%), falls (30%), blunt objects (2%) and other causes (2%). The 12 other causes included collision at play (2), assault (2), rape (1), child abuse (4) and unknown cause (3) (Fig. 2). The motor-vehicles involved included motorcycle (32%), automobile (27%), truck (19%), other motor-vehicles (12%) and unknown motor-vehicles (10%). The roles of the victims in traffic accidents included pedestrian (52%), passenger (20%), bicyclist (14%), motorcyclist (4%) and other (10%) with unknown roles. The nature of falls included falls from height (65%), bicycles (12%), stairs (8%) and others (15%). The most common place for head injuries to occur was outdoors, with the road the most common; while the bedroom was the most common place for indoor injuries to occur.

Time Factors

There were more head injuries in summer time (from May to August) (Fig. 2). The onset time of head injuries clustered at 3:00-5:00 pm (Fig. 3). There were 60.98% of children transported to hospital in less than 6 hours, while only 21.41% of children delayed more than one day.

Hospitalization

The types of admission were emergency

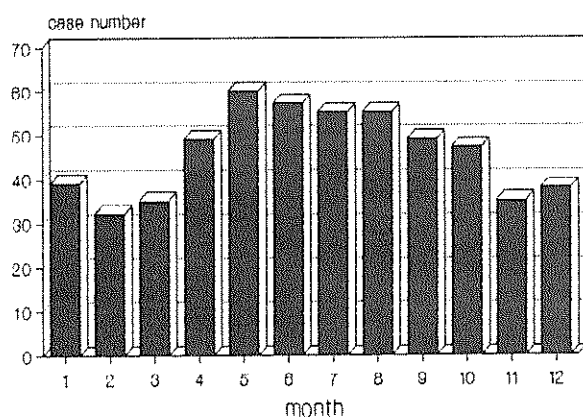


Fig.2 Monthly Distribution

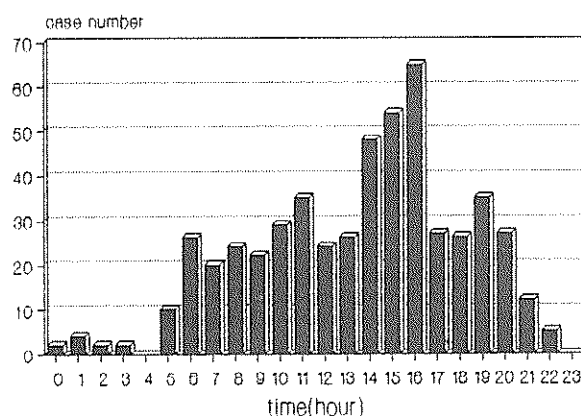


Fig.3 Time Distribution

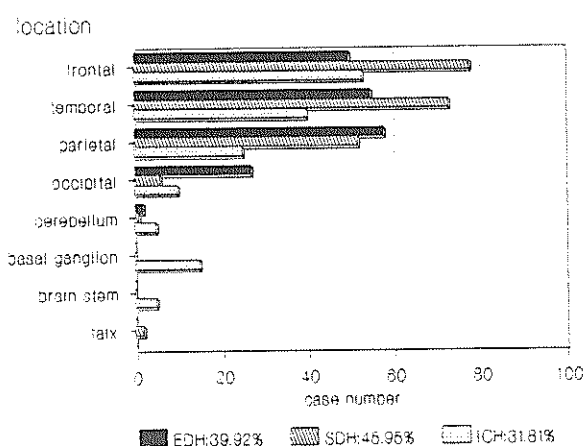


Fig.4 Focal brain CT findings

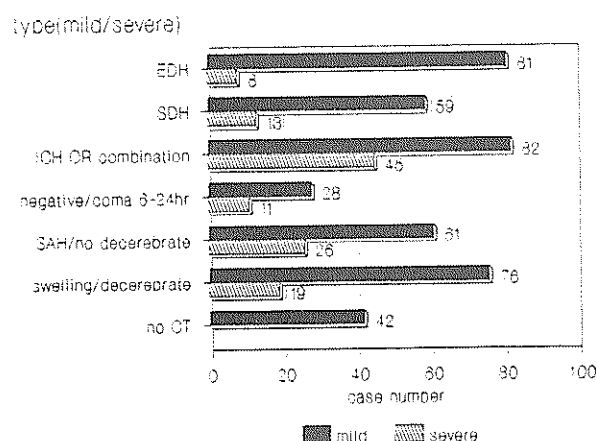


Fig.5 Classification of head injury

room by referral (77%), emergency room directly (21%) and outpatient department (2%). Length of stay varied from discharge from hospital within 3 days (23.59%), within 3-7 days (37.03%), within 7-14 days (23.41%) and more than 14 days (15.97%).

Associated Injury

The type of associated injuries included skull fractures (25.23%), concomitant skeletal fractures (17.06%), other injuries of the nervous system (10.53%), chest trauma (9.62%), abdomen or pelvis trauma (2.0%) and severe orofacial trauma (3.44%). In skull fracture, 42% were linear, 10% basal skull, 9% compound, 9% depressed 12% other type of fractures (such as comminuted fracture, facial bone fracture or suture diastasis) and 18% with unknown type. The other concomitant skeletal fractures included

fractures of the clavicle (32%), upper limbs (31%), lower limbs (22%), pelvis (5%), spine (8%) and shoulder (2%).

Computer Tomogram (CT)

CT examination of brain was done in 509 children (92.37%), with 94.50% having abnormal findings, including diffuse or focal brain lesion. Focal intracranial hemorrhages, included subdural hemorrhage (SDH, 45.95%), epidural hemorrhage (EDH, 39.92%) and intracerebral hemorrhage (ICH, 31.81%). The frontal (37.63%), temporal (34.93%) and parietal (28.07%) areas were the most common focal sites of injury. The remaining sites included the areas of the occipit, cerebellum, basal ganglion, brain stem and falx (Fig. 4).

Severity of Injury (Fig. 5)

Most children, 429 (77.86%), suffered from mild head injury, including 222 focal brain lesions, 137 diffuse brain lesions and 28 with no abnormal finding on the computer tomogram and 42 who did not have computer tomogram. Focal brain lesions included 81 with EDH, 59 with SDH and 82 with ICH or other focal lesions. Diffuse lesions included 61 with SAH (subarachnoid hemorrhage) only and 76 with brain swelling associated with or without SAH.

The remaining 122 children (22.14%) suffered from severe head injury, including 66 focal lesions (54.10%) and 56 diffuse lesions (45.90%). In focal lesions, 8 had EDH, 13 SDH and 45 ICH or other focal lesions. In diffuse lesions, 11 children developed coma within 6-24 hours and 45 children developed coma more than 24 hours post-injury. Of these 45 cases, 19 cases were associated with decerebration of flaccidity and 26 cases were not.

Surgery

One hundred and eight children (19.60%) underwent one or more brain surgeries, including 86 by craniotomy, 5 by crainotomy with lobectomy or brain debridement, 6 by ventriculostomy or ventriculoperitoneal shunt and 13 by subarachnoid screw, which was used for monitoring intracranial pressure. Thirsty-nine children (7.08%) underwent one or more other major surgeries, including fixation for bony fracture (15), laparotomy (8), thoracotomy (8) amputation (2), surgical debridement or skin graft (12) and donor transplantation (2).

Mortality

Among the 551 children with head injuries, there were 50 critical discharges or deaths, excluding the death at the scene. The mortality rate was 9.07% for all children with head injuries and 40.98% for the children with severe head injuries if the critical discharges were considered as death.

DISCUSSION

On hospital admissions, head trauma was present in 25% to 40% of cases reviewed by Molnar (1). But the true incidence rate of head injuries in children may actually be greater because some brain injuries to children may not have led to hospital admission or child abuse may be underreported (9). For all age groups, there is a higher incidence of head injuries for males compared with females (2.3:1) in this study. This was similar to other studies (3,9). Kraus studied 709 brain injured children under the age of 15 in San Diego, California during 1981. His study showed that the male: female ratio was 235:132. The brain-injury rates were higher for boys than for girls at all ages, but the difference was statistically significant only for those children 5 years of age and older (9). Ivan conducted a study of 880 children less than 15 years and confirmed a boy to girl ratio of about 2 to 1 (3). This may be due to the fact that boys participate in more outdoor activities than girls.

In many series in other countries, the leading cause of head injury in children was falls (35% in Kraus, 66.6% in Ivan and 50% in O'Rourke) (3,9,14,15). However, it was quite different in this study, traffic accident was the main cause of head injury (65%) and fall was only the second (30%). This may be due to the poor traffic conditions in Taiwan. The major reason for injury in traffic accident included unprotected pedestrians (52%) and bicyclists (14%) and passengers (20%). this was similar to other series of pediatric groups (9,16). But this was markedly different from the distribution among persons of all age groups (child and adult), for whom two thirds of brain injuries resulting from motor vehicle accidents were to motor vehicle occupants and only one third to unprotected pedestrians or bicyclists (17). The poor condition of traffic should be restrained legally in Taiwan, in ad-

dition to the use of seat belts, car seats for young children, cycle helmets and construction of bicycle lanes and clearing of obstructed sidewalks.

A head injury with an unknown prevalence in infants and young children is that which is the result of child abuse (1). Kraus noted 11 children (1.47%) who were identified as being the victims of child abuse (9). But in our series, there were only 4 children (0.72%) found to be victims of child abuse. Child abuse cases may have been underreported in this study; it may have been misclassified as falls or other nonintentional incidents, or not even brought for medical care.

Ivan noted that children less than 3 years of age were more commonly injured indoors, while the older children were usually outdoors (3). In our series the most common place for head injury to occur was the road, because the main cause of injury was traffic accident. There were more head injuries in summer time and clustered at 3:00-5:00 pm in this study. This was similar to other series (3,9,14). This may be due to more outdoor activities in summer time and the afternoon.

Motor vehicle-related accidents accounted for the vast majority of severe head injuries with multiple trauma in many series (1,15,18). In this study, there were 122 children (22.14%) who suffered from severe head injury, which was much higher proportion than Kraus' (5%) and Ivan's (3.86%) series (3,9). This may be due to the higher proportion of traffic accident in our series.

In this study, the mortality rate was 9.07% for all head injured children and 40.98% for severe head injured children if critical discharge is considered as death. Kraus noted that the mortality rate was 2.77% (19/688) for all head injured children and 52.77% (19/34) for severe head injured children (9). Ivan noted that the mortality rate was 0.9% for all head injured children and 24% for severe head

injured children. From 1980 to 1985, motor vehicle accidents resulted in a mortality of 37% in comparison to a 2.2% rate associated with falls (1). So the higher mortality rate in our series may be due to the higher proportion of traffic accidents. This study is a primary report on the epidemiology of pediatric head injury in our hospital, further research and investigation are needed for the exposure factors, effectiveness of countermeasures and outcome of pediatric head injury in defined populations (infants, children, adolescent and young adult group). It may clarify the most effective measures for the prevention of head injury in children, which is the leading cause of accidental death and most common reason for inpatient admission to pediatric rehabilitation.

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兒童頭部外傷 551 例之分析

陳嘉玲 黃美涓 張允藍*

為瞭解臺灣地區兒童頭部外傷的情況，以期找出有效之預防措施，本研究取自民國74年元月至民國78年12月共5年間，因頭部外傷至本院住院之兒童共551位。經由病歷查閱及問卷調查方式，加以統計分析。

個案以男性居多（男：女=2.3:1）。年齡分佈以小於1歲，4-5歲及14-15歲兩組佔最多數。受傷地點以戶外最多，其中以馬路上受傷高居首位。戶內受傷者則以臥室最多。受傷原因以車禍佔最多數（64.97%），其中以被汽車及機車撞倒高達58.66%。跌倒者次之，佔30.49%，其中以高處跌下為主。受傷發生率最高的季節是夏天，以5、6、

7、8月最多。受傷時間則大多發生在下午3時至5時。以受傷程度而言，大部份兒童屬於輕度頭部外傷（77.86%），但嚴重頭部外傷者仍有122位（22.14%）。有25.23%兒童併有頭骨骨折，其中以線性骨折最多。併發其他部位骨折則以鎖骨及長骨最常見。電腦斷層攝影顯示常見受傷部位依次為額葉，顳葉及頂葉。其中有108位兒童需要接受腦部手術治療（19.60%），其中有50位因死亡或病危自動出院，佔9.07%。

問卷調查目前僅收回131份回函。其中有121位得到相當良好的恢復，佔92.37%。