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Epidemiology of Head Injury —A Review of International Studies—

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ABSTRACT

A review of the international epidemiologic studies of head injury is undertaken to evaluate the recent major findings on the occurrence and variation of head injury in populations across the world. The definitions and methodologies used in these reported studies appeared to vary considerably. There was a 3-fold variability in the incidence rates of head injuries among studies and a 10-fold difference in mortality rates. This variabilty may be partially explained by different definitions and methodologies used. However, a true different definitions and methodologies used. However, a true difference related to the major causes of injury in each area is also likely. An international collaborative effort with a standardized approach is highly remommended and a few recommendations in the directions of future studies are hereby given.

Trauma is the leading cause of death for those under 40 years of age in most countries. (1,2) over one-half of the trauma relateddeaths result from head injury. Survivors from head injury frequently have severe neurological sequelae and require prolonged hospitalization with the use of sophisticated aftercare facilities. The impact on society in terms of costs and the use of medical resources is enormous, yet many societies seemed to be oblivious to the ill effects caused these rampant cases of head injury. The increasing demand on better medical system has promoted the necessity of population-based studies of head injury in order to understand its causes, sequelae and mortality, and to identify the factors associated with head injury, making it possible to study means in reducing the magnitude of this problem.

Although the medical literature on head injury is extensive, the emphasis is mainly clinical. Epidemiologic research examining the distribution of head injury is limited. The purpose

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of this review is to evaluate the recent major findings on the occruuence and variation of head injury in defined populations across the world. This report will focus on the methodology used in these studies, including definitions of head injury and case ascertainment methods. We will also review the incidence rates, causes of injury, and mortality rates in the studies. Some approaches for the evaluation of data for future studies will be suggested.

It is important to begin with monitoring the magnitude of the problem associated with head injuries across the world. This is especially important in developing nations as they consequently enter into the epidemiologic transition between infections diseases and chronic diseases. It is likely that during this time, there is a rapid increase in the problem associated with head injury due to a marked increase in accessibility to the major agents associated with major head injuries : automobiles and motorcycles. Of all the major health problems associated with the epidemiologic transition state, perhaps head injuries are more amendable to primary prevention than other chronic conditions such as coronary heart diseases, cancers and diabetes.

Previous literature has provided important reports and critical insights into the magnitude of the problem and the best approaches for conducting a global surveillance. It is important to begin to map the incidence of head injuries in varied populations over time. An analysis can be made as to where the problem lies and what can be done to help prevent this unfotunate occurrence which is maleficent especially to a still progressing world.

Overview of International Studies

Before 1980, only a very few, scattered and incomplete reports on population-based studies of head injuries were available. (3,4,5) When Annegers and Kurland reviewed the literature in 1979, they were only able to identify two population-based studies; one from a vaval base and the other from the Health Interview Survey. (5,6) Since then, however, there has been at least 16 population-based studies of head injury published. We will review these studies by country.

United States

The first population-based study of the incidence, causes, and secular trends of head injury was published by Annegers et al. in 1980. (7) This study described the incidence of head injury among residents of Olmstedt County, Minneosota for the period of 1935 to 1974.

The National Head and Spinal Cord Injury Survey (HSCI Survey) reported a large scale probability survey sample in 1980 estimating new cases and the resulting economic costs of head and spinal cord injury for the civilian US population during 1974. (8)

Several studies have evaluated urban and rural areas in the United States. Studies on Chicago (Whitman, 1984) and Bronx County, New York (Cooper, 1983) are two representatives of urban populations. (9,10) These studies emphasized demographic differences, socioeconomic factors and unusual causes of death. They found higher incidence rates and mortality rates than those found in other US studies. The assault rate appeared extraordi-

narily high in these areas (40% in Inner City, Chicago and 33% in Bronx County). A study in North Central Virginia (Jagger, 1984) focused on the rural population. (11) The incidence rate was relatively low and the main cause of injury was traffic accident.

There were two separate studies completed in San Diego County. One by Lauber et al. in 1978 and the other by Kraus et al. in 1981. (12,13) They used different definitions and methods. Although the population appeared to be the same, the results appeared somewhat different in two studies. The incidence rate was higher in the former and the mortality rate was higher in the latter.

The most recent report on the epidemiology of head injury is from a study done in Rhode Island during 1979 and 1980 regarding the incidence and outcome of head injury cases (Fife et al., 1986). (14)

The US studies reviewed here used somewhat different survey designs, definition and case ascertainment methods. Frankowski et al. in their review of the descriptive epidemiology of head trauma in 1986 suggested " the adoption of standardized definition and procedure to facilitate comparability among future studies". (15,16)

Britain

Bryan Jennett, one of the renowned neurosurgeons who first developed the Glasgow Coma Scale, reported the estimated yearly rates of deaths, hospital admissions and attendance after head injury in Scotland, England and Wales in 1981. (17) Patients include those with either a history of a blow to the head, altered level of consciousness, with a scalp or forehead laceration, or those who had a skull x-ray examination. In his opinion, hospital admission provides the most readily available data for comparisons between different places but these data have to be interpreted in the light of local facilities and policies. He also compared the results of neurosurgical care and primary surgical care of the head injured patients in different areas.

Norway

Two epidemiologic studies of head injury were completed in Norway ; one was done in Trodelag in 1979—1980 (Edna, 1984) and the other in Arkershus Country in 1974 (Nestvolt, 1988). (18,19) Both studies revealed unusually low mortality rates in spite of their high rates of traffic accidents.

Sweden

Nyqren et al. reported the epidemiology of head injuries in Sweden in 1986. (20) He estimated that 25,000—30,000 persons incur head injuries in Sweden each year.

San Marino and Italy

A study of head injuries was carried out in the smallest nation of the world (Republic of San Marino) from January 1981 to December 1982 (Servadei, 1985). (21) The results showed a very high annual incidence rate. Traffic accidents here were the leading cause of injury, This study, likely, is representative of the incidence of head trauma in Northern Italy.

Cnanda

A prospective, computerized study of head injury was performed in Winnipeg (Parkinson, 1985). (22) This study concluded that the incidence was highest in the unemployed and the welfare recipients. Traffic accidents were the leading cause. Incidence of head injury associated with fights was also very high.

Australia

A study of hospital separations for head injuries in South Australia was completed in 1980—1981 (Woodward, 1984). (23) The annual rate was the highest in the world. Country residents were found out to be at incresed risk.

Taiwan

A pilot study of head injuries was conducted in Taipei City in 1983. (24,25) The two most striking findings in this study were the extraordinary high rate of motorcycle accidents and very high mortality ad morbidity rates. Recently, there has already been a concerted effort on a nationwide scale research to investigate head and spinal cord injury in Taiwan. This study having been started on July 1, 1987, is presently in its 4 th year of research. The intended duration of this study is up to June 30, 1993, a period covering 6 years. This study aims at elucidating the secular trend of head injury in this country.

France

A study of head trauma (including non-hospital deaths) over a one-year period in Aquitaine, France with a population of 2.7 million was completed in 1986 (Tiret, 1990). (26) Higher rate of traffic accidents (60%) as the main cause of head trauma was found. Comparison between the outcome and the Injury Severity Scale (ISS) were also done in this study.

It is important to compare these studies to make conclusions concerning the epidemology of head injuries. However, this is difficult to accomplish because of marked differences regarding the definitions used and thus, the choice of subjects to be included in the studies. So as to arrive at significant and accurate results, these differences have to be minimized, if not obliterated.

INTERNATIONAL COMPARISON

1. Definitions and Case Ascertainment

The definition of head injury varied considerably in the published studies. Among the 16 studies, six used" discharge or physician's diagnosis" to define cases of head injury without presenting a clear description of its definition. (13,14,22,23,25,26) The remaining ten studies defined head injury by clinical findings, but none of them were identical. (7,8,9,10,11,12,17,18,19,21) Four main clinical symptoms and signs were commonly applied to define head injury in the studies (Table 1). These included loss of consciousness in all 10 studies ; posttraumatic amnesia in 6 studies ; neurological deficits in 4 studies ; and seizures in 4 studies. Two clinical diagnoses were also used to define head injury namely, skull fracture in seven studies and inrtacranial hemorrhage in 3 studies.

Based on the above, most series employed

Table 1. The Incidence Studies of Head Injury in Population Based Studies

Population	Incidence (/100,000)	Peak Age (Years)	M/F Ratio	Black / White Ratio	Peak Season
Olmstedt County	193	15-24	2.3	—	Summer
NINCDS	200	15—24	2.1	0.9	Summer
San Diego (1978)	295	15—19	1.3—2.8*	—	Spring
Bronx County	249	20—29	2.1	1.3	Summer
North Central Virginia	208	15—19	2.4	1.5	Summer
Chicago					
Inner City	403	25—34	2.5	2.0	Spring
Evanston (black)	394	0—1	2.8	—	Spring
Evanston (white)	196	0—1	2.3	—	Spring
San Diego (1981)	180	15—19	2.2	—	—
Rhode Island	152	15—25	2.0	—	—
England & Wales	270 * *	15—19	—	—	—
Trodelag, Norway	200	15—19	2.3	—	Summer
Akershus, Norway	236	10—19	1.9	—	—
South Australia	470 * * *	15—24	2.2	—	—
Winnipeg, Canada	220	20—29	2.2	—	Spring
San Marino	468	—	2.1	—	—
Taipei, Taiwan	240	20—29	2.3	—	Summer
Aquitaine, France	281	15—19	2.1	—	—

* Range of ratios by age
* * Range 210—360
* * * City 430; Country 570

the system of choosing subjects who had clear-cut evidences of brain injury, brain concussion, or skull fracture. An alternative approach was to employ clinical manifestations, such as loss of consiousness, post-traumatic amnesia, neurological deficit and seizures, as well as by diagnoses such as skull fracture and intracranial hematoma. The use of " physician's diagnosis" would not offer high reliability in as much as the diagnosis of cases could vary among physicians. Nevertheless, not all cases of head injury are admitted so not a negligible number may be missed.

In addition to the definition, a severity scale is very important. This identifies the extent and severity of head injury for comparison. Surprisingly, only 3 of 15 studies used scales to classify the severity of head injury. (7,9,13) Even in these studies, the scales were not uniform.

The study in Olmsted Country was the first to use a severity scale. (7) The different degrees of severity used were as follows : 1) fatal - death within 28 days ; 2) severe - intracranial hematomas, contusion, loss of consciousness or post-traumatic amnesia over 24 hours and 4) mild - loss of cosciousness or post-traumatic amnesia below 30 minutes. Whit-

man et. al in their Chicago study also employed this classification but a fifth degree, i.e. trivial, was added. (9) The main drawback with this severity approach is that it relies too much on the duration of loss of consciousness as the basis for classification. It is a fact that it is often very difficult to evaluate the exact time when the patient actually regained consciousness.

Another approach was the one used by Kraus et al. in his 1981 San Diego study. (13) Those with a Glasgow Cowa Scale (27) score of 8 or lower were termed severe. The remaining patients, all of whom had a Glasgow Coma Scale score of 9 or greater, were termed moderate, if they had a hospital stay of at least 48 hours and with one of the following : brain surgery or an abnormal CAT scan, or a Glasgow Coma Scale score of 9-12. The rest were termed mild. This approach is consistent with that suggested by Jennett and Teasdale (28) and Levin et al.. (29) The Glasgow Coma Scale is commonly used in most countries, and its evaluation of the level of consciousness is more reliable. In the future studies, a severity scale should be incorporated with the use of the Glasgow Coma Scale as it is the best approach for standardization.

The case ascertainment methods greatly influenced the value for the incidence of head injuries. All 16 studies, including our study in Taipei, used medical charts of hospital in-patients as the primary source of data. Ten studies included non-hospital deaths (i.e., patients who died on the scene or during transport to a hospital (7, 9, 10, 12, 13, 14, 17, 19, 23, 26) and five studies used emergency room visits. (7,10,12,13,21). It is important that cases leading to death be included in order to determine the accurate magnitude of the occurrence of head injury. Only Annegers et al. included out-patient examinations and home visits in their study. (7)

It can be noted that most series tended to ascertain the cases by choosing in -patients and non-hospital deaths as their subjects. Emergency room visits and out-patients were used less frequently because apparently, they include too many mild, trivial or suspected cases. Identification of all the relatively mild cases of head injury is almost impossible as many do not come to the emergency room but are seen by family physicians. Some do not even seek medical consult. In order to achieve some degree of uniformity and, cconsequently, comparability among studies, it is recommended that only the upper spectrum of severity be included, i.e., those cases that would result to hospitalization or death.

Despite the variability of definition, general conclusions can be reached regarding the epidemiology of head injury accross the world.

2. Incidence Rates

Table 1 present the incidence rates in 16 reported studies. The range was from 152/100,000 in Rhode Island, USA to 470/100,000 in South Australia. (23) In the latter, 403/100,000 city residents and 570/100,000 country residents were at risk of acquiring head injury from different causes. The investigator (Woodward et al., 1984) explained that a factor that might have contributed to the high incidence rate in this area was the practice of admitting patients with even less severe head injuries, expecially in the country area. However, this did not essentially explain the extraordinary rate.

In North America, the annual incidence rate of head injuries ranged from 152/100,000

to 403/100,000 with the highest rate in the Inner City of Chicago. (9) The higher rates in urban areas were proportionately related to the higher incidence of assault as a cause of injury. Rhode Island had the lowest rate in the reported studies in US as well as in the world. (14) The annual incidence rate in Winnipeg, Canada was 220/100,000 which was very close to the average rate of US. (22)

Data regarding the incidence rate of head injury in Europe were available for Britain, Norway, Sweden, San Marino and France. (17,18,19,20,21,26) The annual admission rate in England and Wales in 1974 was 270/100,000, with range of 21/100,000 — 360/100,000, while in Scotland it was 313/100,000. Trodelag and Akershus County in Norway had 200/100,000 and 236/100,000, respectively. Aquitaine in France was 281/100,000. The rate was slightly higher in Sweden, with an estimated annual rate of 300—360/100,000(Nygren et al., 1986). Interestingly, the incidence in the smallest nation in the world, the Republic of San Marino, was 468/100,000 which was the highest value among these European studies.

The annual incidence rate in Taipei, Taiwan was 240/100,000 in 1983, which was about the average value. (24,25) There were no reports from other Asian Countries.

Based on the above findings, we can conclude that incidence rates of head injury demonstrated over a 3-fold variability among studies. The difference may be partially explained by different case definitions as well as methods of ascertainment used in the different studies. Essentially, however, the results could really have been genuine representation of the rampancy of head injury cases in each of the area studied and the differences between countries may as well reflect the different life conditions which affect, to a large degree, the accessibility of the inhabitants to the major agents of injury.

3. Age, Sex, Race, Time Trends and Season

Most head injuries occur in youths and young adults, but older persons also appear to be vulnerable. In most of the reported studies, a bi-modal pattern of the age—specific incidence of head injury was reported. Specifically, twelve out of 14 studies had a pead incidence between 15—29 years old. out of these 12, six studies showed a peak at age 15—19, four studies at 15—24, and the remaining 3 studies at 20—29. The Chicago study was the only exception with a peak incidence at ages 25—34 in Inner City and at a very young age of 0—1 year in Evanston. A secondary peak was commonly identified at the age of 60—70.

The incidence rate in males is twice that of females, the ratio ranging from 1.3—2.8. Thirteen out of 15 studies showed sex ratio values grater than 2.0 with the highest at 15—24 age group regardless of the race and geographic area. The males outnumbered the females in all age groups. The higher rates in males may be partly due to social and environmental factors that increase exposure of males to greater hazards. Alternatively, it may be a consequence of physical or psychlolgical factors that cause males to have more aggressive and risky behavior.

Only four U.S. studies reported racial differences in the incidence of head injuries. Three out of four American studies showed that the incidence rates for non-whites (mainly blacks and Hispanics) were considerably higher than those for whites. (8,9,10,11) The racial differ-

ences were considered to be related to socioeconomic status and environmental factors. (30, 31) In contrast, the HSCI survey in US reported a higher incidence rate for whites than for non-whites. The reason for this discrepancy between the national study and other community studies is not known. Speculations regarding this discrepancy offered by Cooper et al. were : 1) The hospitals included in the HSCI survey were not chosen to provide race-specific estimates, hence, there may be an increased likelihood of undernumeration of small racial groups; 2) there may be variations in health care seeking behavior between whites and non-whites for head injury where whites have greater access than non-whites ; 3) urban non-whites have an increased risk for head injury due to socioeconomic or environmental conditions. (9)

Apparently, specific accidents and events occurred at a particular time of the day. Motor vehicle accidents peaked around six o'clock in the evening. The occurrence of interpersonal violence reached the highest point at the later evening hours (about 9—12 p.m.). A somewhat different picture was seen in the cases of falls in which the peak commonly occurred in the afternoon. It should also be noted that there was a higher frequency of occurrence of injury during weekends than weekdays.

Most studies identified peak occurrence of head injury in different seasons. Six studies showed peak incidence in summer and three in spring. Peak occurrence during summer may be related to increased frequency of outdoor activities during this period. Moreover, traffic accidents and interpersonal violences had the highest rates during the summer period. Not unexpectedly, in the northern climates, head trauma from falls were more common during winter than in other seasons.

4. Causes of Head Injuries

The causes of head injury varied greatly among countries and areas. Most American studies reported that three leading causes ranked in sequence were traffic accidents, falls, and interpersonal violences. However, two urban studies in Inner city, Chicago and Bronx County, New York showed a considerably different report. Here, interpersonal violence was the main cause (40% & 34%, Table 2), while traffic accidents accounted for a surprisingly low percentage (31% & 27%). The study in Winnipeg, Canada also had a higher rate for assaults (28.5%).

Most U.S. studies, and the studies in Winnipeg, Canada and South Australia found a relatively high rate due to falls with a range of 20—35%. In contrast, Britain and Taiwan had a lower rate of falls with 16% and 12%, respectively, In Akershus County of Norway, San Marino, France and Taipei, the incidence of head injuries caused by traffic accidents were significantly high. In our study in Taipei, an extraordinary 74% were due to traffic accidents, 81% of which were caused by faulty motorcycle driveing.

Some studies have also reported that the causes varied with age and sex. Not suprisingly, traffic accidents and interpersonal violence were higher in young males aged 15—24 than those of other age and sex groups.

5. Secular Trends

The study by Annegers et al. was the first to examine the secular trends in head injury. (7) They reported that the incidence rate for head injury was lower in the 1930's and 1940's. This was porbably related to the socioeconomic

Table 2. Proportion of 3 Main Causes of Head Injury Reported in Population Based Studies

Study	Traffic Accidents	Falls	Assaults
Olmstedt County	46%	29%	6%
NINCDS	49%	28%	—
San Diego (1978)	53%	31%	11%
Bronx County	27%	32%	34%
North Central Virginia	55%	20%	11%
San Diego County (1981)	48%	21%	18%
Chicago			
Inner City	31%	20%	40%
Evanston (black)	32%	21%	26%
Evanston (white)	39%	31%	10%
Rhode Island	39%	35%	9%
England & Wales	34%	16%	—
Trodelag, Norway	45%	—	8%
Akershus, Norway	58%	25%	—
South Australia			
City	32%	28%	13%
Country	31%	23%	5%
Winnipeg, Canada	32%	28%	29%
San Marino	62%	—	2%
Taipei, Taiwan	74%	12%	4%
Aquitaine, France	60%	33%	—

conditions during the Great Depression, World War II, causing reduced need of and access to motor vehicles. The incidence rate increased progressively during the next 40 years.

Recently, a study was completed by Klauber et al. which examined meticulously the decline in head injury mortality rate in San Diego County during the period of 1976 to 1982. (32) Their results indicated that during 1976—1980, there was nearly a constant death rate from head injuries, which was followed in the next two years by a decline of 24%. The decline was unlikely the result of a reduced incidence. Apparently, the advent on advanced prehospital emergency medical service (EMS) substatially reduced the mortality rate in injured patients.

Clearly, more information is needed concerning secular patterns from other areas, especially in the rapidly industrializing countries which, in the process, are undergoing a dramatic epidemiologic transition.

6. Mortality Studies

The mortality rate is an important indicator to evaluate the severity and outcome of head injuries. It represents the number of death due to head injuries in a given period of time for an estimated midinterval population of a specific area. The case fatality ratio (CFR), a percentage estimation of outcome, is the number of deaths over the total number of head injuries.

Table 3. Annual Mortality Rates (Per 100,000), Male/Female Ratio, Relative Frequency of Hospitl and Non-hospital Deaths and Case Fatality Ratio (CFR) in Head Injury

Study Population	Mortality Rate	M/F Ratio	Hospital Deaths	Non—hospital Deaths	CFR
Olmstedt County	22	3.5	—	—	12.4%
Bronx County	27.9	5.0	28.5%	74.2%	27%
Chicago	—	—	33.3%	66.7%	—
Inner City	32	4.6	—	—	7%
Evanston(Black)	19	2.2	—	—	6%
Evanston(White)	11	2.3	—	—	5%
San Diego County (1978)	22.3	2.6	35%	65%	* 3%
San Diego County (1981)	30	4.5	31.3%	68.7	* * 17%
North Central Virginia	13.5	—	—	—	6.5
Rhode Island	52	—	39%	61%	8—12%
England & Wales	9	—	30%	70%	0.8%
Trodelag, Norway	5.5	—	—	—	2.8%
Akershus, Norway	6.5	2.3	30%	70%	5.1%
South Australia					
City	31	—	21%	79%	0.4%
Country	22.5	—	37%	63%	1.4%
Winnipeg, Canada	37	—	—	—	4.4%
Taipei, Taiwan	38	—	—	—	16%
Aquitaine, France	22	2.8	—	—	4.4%

* Died during hospitalization

* * 6% died during hospitalization

Table 3 present the distribution of mortality rates, the CFR's, the male to female ratio and the percentages hospital and non—hospital deaths.

There was over a 10-fold difference in the mortality rates between the lowest and highest risk areas, Norway and Rhode Island, respectively. Reasons for the wide discrepancy are not known. It is surprising that the mortality rates do not parallel the incidence rates. Rhode Island, for example, had the lowest incidence rate but the highest mortality rate. The author explained that the low incidence rate was due to three potential sources of error in case ascertainment. Residents injured out of the state, nonincident cases, and cases taken to a morgue without being admitted to a hospital were not accounted for. High mortality rate, on the other hand, was possibly due to overlapping of deaths of hospitalized patients and medical examiner's cases.

Geographical influences may play a major role. All four urban areas, including Inner City in Chicago, Bronx County in New York, Winnipeg in Canada and city areas of South Autralia, had a higher mortality rates(28—37/

100,000). In these areas, assaults were found out to be very common. Taipei City, a typical urban area, on the other hand, had motorcycle accidents as playing the major role in the causation of head injury and the high mortality rate here could be attributable to the seriousness and severity of injuries that these accidents could produce.

Data on relative frequency of hospital and non-hospital deaths could be obtained from 9 studies. It is important to note that in at least two thirds of cases, death occurred prior to hospitalization (60—79%), which could then be labeled as the critical period. Hence, primary prevention and an efficient emergency medical system are much more important than an intensive treatment in the hospital in reducing mortalities. This could be proven by a recent study in San Diego County. Klauber et al. found that the number of deaths at the scene declined 28% and the number of individuals listed as dead on arrival delined 68% in 1981—1982 after a marked improvement of the county's emergency ground and prehospital air evacuation services. (32) Similarly, in South Autralia as mentioned above, the proportion of non-hospital deaths was higher in the country than that in the city (79% versus 63%). There was a strong evidece that the rural ambulance tended to reach their patients after longer delays.

The CFR varied from 0.4% to 27%. Males were more likely to die than females in all studies.

CONCLUSION

The epidemiology of head injury reported from 8 contries after 1980 was reviewed. The definitions of head injury used in these reported studies varied considerably, but mainly focused on relatively severe injuries. Most studies tended to use hospitalized in-patients and non-hospital deaths as their subjects.

The annual incidence rate of head injury varied from 152/100,000 to 470/100,000. South Autralia had the highest incidence rate among the reported studies. Using these figures, we can estimate that the lifetime risk for acquiring head injury is from 11% to 33%, placing average life expectancy at 70. This value is significantly high. Most studies presented a bimodal pattern with first peak between 15 and 29 years and the second peak at the age 60—79. Males were twice as likely to have severe head injury as females. Traffic accidents posed as the most common cause in most studies, with very high rates in countries undergoing rapid industrialization, such as Taiwan. However, in some urban areas in the United States, the most common cause was interpersonal violence. Six studies reported a peak incidence in summer and three in spring.

The annual mortality rate from head injury ranged from 5.5/100,000 to 52/100,000, and the case fatality ratio varied from 0.4% to 27%. over two-thirds of those with head injuries died prior to hospitalization. The annual incidence and mortality rates appeared to be closely related to the accessibility to the causes of head injury.

Most studies were completed in the westernized and industrialized contries, the single exception being Taiwan. There were no data from other non-westernized contries. Even in the studies completed in the westernized contries, the methodologies used were not consistent.

Faced with these facts, it becomes incum-

bent upon an epidemiologist to systematically determine the magnitude of the preblem, analyze the factors leading to and aggravation it and most importantly, formulate and implement schemes in order to combat it. This particular study has opened the avenue towards a better understnding of this problem that besets every nation. However, an international collaborative program with a standardized approach would be very ideal.

RECOMMENDATIONS

1. As suggested by Jennett and Frankowski, there is a critical need for a standardized definition of head infury as well as severity classification of injury so that data can be compared among studies. Based on the analysis of previous studies, we suggest the following :

a. Definition — Subjects include patients with evidences of brain injury or concussion and skull fracture. These may be demonstrated clinically by loss of consciousness, post-traumatic amnesia, post-traumatic seizures, neurological deficits, and intracranial hematomas. Skull fracture is also included because it usually is associated with minor or major intracranial complications. This definition was chosen because it makes the cases easily quantifiable, it offers minimal variability of diagnosis between physicians or communities, and it includes cases severe enough to require medical attention.

b. Case ascertainment — The use of hospitalized in-patients and non-hospital deaths (deaths prior to hospitalization) is probably the best case ascertainment procedure that can be employed.

c. Severity Scale and Outcome Scale— Glasgow Coma Scale (GCS) and Glasgow Outcome Scale (GOS) are widely accepted by most countries and can be easily obtained from medical charts. (27,33) The use of GCS and GOS to classify the severity and outcome of head injury on a population basis is needed.

2. There have been very few studies reporting secular trends. This aspect should be delved into deservingly in future studies as it provides an overview of effects of significant socioeconomic changes on the problem, and in the process, it makes us vigilantly aware.

3. Data from underdeveloped and developing countries are lacking. Except Taiwan, all of the epidemiologic studies have dealt with developed and industrialized contries. There are no available data concerning the epidemiology of head injury in South America, Africa, and most Asian countries.

4. Long term follow-up studies of head injury are needed to evaluate the sequelae of head injury on a population basis. Recently, the occurrence of post-traumatic seizures has been observed and clinically studied. (34,35,36,37) Other problems such as post-traumatic psychosis and post-concussional syndrome have caught little attention in population studies. It is essential to use population-based registries to determine the natural history of head injury.

5. Futher studies about the relationship between racial differences and incidence of head injury are necessary. The results revealed by 4 studies in the United States were rather conflicting.

6. Case-controlled studies are required to provide further information about the mechanism and prevention of head injury. A focus on the relationship between the occurrence of head injury and environemntal factors (e.g., car

design and road design) and behavioral factors (e.g., drug and alcohol use) will be helpful.

7. Children and older groups should be studied separately. The mechanism leading to and results of head injury in the two groups are relatively different.

8. There is a need to study the referral procedures and the availability of modes of transportation (e.g. helicopter or ambulance) in dealing with emergency head injury cases in each area. Comparison of the outcome of head injuries from population-based cohorts having different emergency medical service (EMS) systems would be very important to our understanding of the effectiveness of the programs.

9. There have only been limited data concerning the treatment of head injury in a population-based study. Further study on the availability and effects of specialized neurosurgical and intensive care facilities in different geographic areas is needed. The outcome of neurosurgical and primary surgical care in different countries should be compared. (17,28)

10. It is essential to determine both the direct and indirect costs associated with head injuries from population studies. The cost associated with preventive care program is far less than the medical and social costs.

11. International cooperative studies of head injury in ethnically and culturally different countries are highly recommended, because these kinds of intercultural studies can evaluate the actual differences of the distributions and outcomes of head injury in different populations.

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頭部外傷流行病學
——世界各地區研究之文獻回顧——

邱文達

本文主要目的爲綜合整理全世界各地區近幾年來已發表之頭部外傷流行病學之發展，探討各國間頭部外傷發生率、原因、危險因子及死亡率等之地區差異性。各地區的研究所採行的方法及頭部外傷的定義，皆有部份的不同。各國報告中，頭部外傷的最高及最低發生率可以達 3 倍左右的差異。而死亡率甚至可以達 10 倍左右。這種差異性可能有部份是由於研究方法的不同，但事實上各地區間，或各國間確實存在某些相當大的文化、種族、經濟等的距離。本文除回顧所有頭部外傷流行病學研究的文獻外，並建議進行國際合作的研究，及對未來研究方向的展望作一陳述。

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