EPIDEMIOLOGY OF HEAD INJURIES

by

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Our approach to this field has followed the common lines of epidemiology as well as of its dynamic modification shown in Fig. 1. However, we feel it equally important to point out the source of responsibilities for the various events and possible improvements (Fig.1). Our approach to the problem is similar to that of William Haddon (1972) in stressing the importance of etiology or prevention, and modification and treatment (Fig.2).

However, in analysis of pretraumatic, traumatic and post-traumatic conditions etiological approaches can be made at all these stages and yet they are linked together (Fig. 3). Therefore, we have regarded the problem as consisting of more or less connected sections, where attack may be direct and practical and responsibility can be pointed out.

Thus among the primary traumatic factors are the general pattern of people involved and the physical environment of the accidents. Then there is the resulting injury pattern.

Related factors involve the most responsible factor, the individual. His age, general behaviour and pretraumatic circumstances as well as neuropsychiatric deficit from previous injuries will influence his capacity as a road user.

When accident types with high percentage of head injuries are particularly common in a community the patterns of injuries in general and of head injuries in particular, will show a similar trend. With increasing motorization the proportion of head injuries could be expected to be higher than in communities with either low traffic density or with highly developed safety measures, particularly with respect to car occupants. Of course, in districts and time periods when cars with low speed fill the roads more brain damage may occur from carbon monoxide than from impacts.

The sex distribution of injuries and head injuries will also be influenced in communities with different percentage of women working in heavy industries, etc.

Studies and prevention of traffic injuries must be accepted as part of occupational medicine, particularly when professional drivers are involved. This will provoke a better recording, especially of the late effects of injuries and the effects on the community.

Finally, there are the demands of the last resort for the hazard of living and for head injured, the medical care.

ACCIDENT PATTERN OF HEAD INJURIES IN TRAFFIC ACCIDENTS (Fig. 3)

Accident reports (Fig. 4) from different countries show that traffic accidents account for 53-70% of all head injuries. Traffic accidents as a quite dominating cause is not reported from India. Another pattern is also shown among children in Scotland. Such percentages are, however, useful only with respect to their relative importance within that region and give no information about the rates of head injury causes in the population which should be useful for comparisons between countries.

However, traffic is the great common head injury agent,and we have concentrated on such injuries in the following account. In an epidemiological survey of injured, hospitalized patients, covering the years 1946 to 1966 in various European countries, Franke (1972) reported that 25 to 35% of the adults and 30 to 50% of the children had head injuries; of these 50 to 60% occurred in traffic accidents.

Frequency and severity

In our literature review (Fig. 5) head injuries represent 30-45% of all injuries sustained in traffic accidents. Moreover,as may as 40-70% of all patients had a head injury.

Although most head injuries are not considered severe, among severe and lethal injuries they account for the main part (Fig. 5). Autopsy materials reveal that head injuries alone are responsible for 50-70% of all traffic deaths.

In spite of these facts there are very few comparable studies on the epidemiology of head injuries, particularly regarding their severity in survivors. Thus we have to report materials examined with various methods and for various purposes and try to give a conception of this field.

The rate of mortality and of hospitalization are two often used indications of the severity of injuries. Regarding head injuries it must be stated that many patients are observed in hospital only due to the potential risk of complications occurring after trauma. Franke in his review found this group to be responsible for 45-75% of admissions. Of 630 traffic and non-traffic head casualties, Klonoff and Thompson in Canada (1969) found 44% to be hospitalized and Hansson, Sweden (1973) in a traffic general material found 41% hospitalized on account of head injuries. Fig. 6 shows the distribution of some head injury diagnoses. There is a high proportion of wounds and intracranial injuries, of which latter concussion alone is responsible for 85-95%. Recognized fractures stand only for 8-16% of all diagnoses.

Kihlberg (1966) found in a Cornell material (1953-1966) that 70% of all injured car occupants or 37.613 had head injuries. 66% of the head injuries were classified as mild and another 24% as "nondangerous" (moderate).

When instead of diagnoses reference is made to the number of patients head injured, Kihlberg in the same material found that 96% had soft tissue damage and 33% intracranial injury. The three most common injuries were in order forehead soft tissue damage (37%), concussion (28%) and scalp injuries (27%). The mortality rate (death within 24 hours) among the head injured patients was 5%.

In a study of 500 necropsies reported by Gissane 1963, 72% of all victims were registered to have brain injuries and 63% to have skull fractures. Among the 102 dead morotcyclists 75% had sustained brain damage and 72% skull fracture. - Jamieson (1971) found that a high death rate among pedestrians was mostly due to brain injuries, being predominantly a city problem.

In another report, on a 15 year Cornell material among 57.597 injured automobile occupants and concerned with the multiplicity of injury Kihlberg (1970) registered an average of 2.3 injuries per person. 70% of all patients had more than one injury; most often the head was involved.

Age and sex

In one of the few studies dealing with this aspect Klonoff and Thompson (1967) found an overall sex ratio of 3:2 for males compared with females in a material from Canada among 630 adults with head injuries from all causes. Not less than 45% of all patients belonged to the age group 16-30 years, but on the other hand patients more than 61 years of age were hospitalized much more often: 66% compared to 35% for the younger group.

In a Swedish material from 1964-68 (patient statistics No 6, Uppsala 1970) including skull fracture and concussion (Fig. 7) measured as number of discharges, the male/female ratio for the fracture group was 5:1 and for the concussion group 3:1. About one fifth of both groups belonged to the category 55 years or older. The distribution of skull fractures was similar to that of concussion but fractures were found only about half as often.

Maloney and Whatmore (1969) among 173 cases of fatal head injuries also noted a male/female ratio of 5:1 (Fig. 8). 70% of the females and 48% of the males were over 50 years at death. The difference between the sexes was greater below 50 years of age, only 13% females under 50, while 29% over 50 years.

Category of road user

Relating head injuries to the total number of all injuries as well as to the number of injured patients (Fig. 9) seems to show no considerable difference between the categories of road users. However, in studies by Wulff et al. (1957) in Scandinavia, Ricklin (1958), Switzerland and Bäckström (1963), Sweden, unprotected road users were subjected to more severe head injuries, according to Bäckström twice as often. There is an overwhelming literature on the various categories of car occupants (Huelke, Jamieson, Nahum & Siegel, Patrick, Ryan) but that is partly outside the scope of this paper.

In traffic autopsy material head injury as the cause of death is more often represented among nonprotected than protected road users.

Season, day and habit

Klonoff and Thompson observed a maximum of visits for the emergency group in autumn and of the hospitalized patients in spring. Both groups attended the hospital mostly in Saturdays and all days between 5 p.m. and midnight.

Franke estimated that among the nonfatal skull-brain injuries alcohol intoxication was found in 10-20% and among the fatal injuries in 30-50%.

Conclusion

From the epidemiological review we can conclude that:

Head injuries account for the main part of traffic injuries and for the overwhelming part of traffic deaths.

Head injuries are often part of multiple injuries.

Unprotected road users receive more severe head injuries than do car occupants.

Hospitalization of head injuries was reported more often in patients above 60 years of age.

Regional study

To give a more homogenous over-all picture of the present day situation we will present a not yet published prospective study of head injuries in traffic accidents (during the year 1970) from a Swedish county hospital (Hansson 1973), including both outpatients and hospitalized patients. The area served is mainly rural.

879 patients, 22% of all hospitalized at the surgical department, had more than 1.100 acute injuries and 38% of these were due to traffic accidents. 6% of all hospitalized patients belonged to this group.

Wounds dominated among the head injuries (Fig. 10) and these were very often slight injuries. In skull-brain injuries are incluced cerebral concussion, cranial fracture and other intracranial injuries.

In 2/3 of the cases, skull-brain injuries were combined with other injuries, most often fractures of the extremities (Fig. 11). Skull-brain injuries were in 75% of the cases the dominating injury among these multiple injured patients.

There was an equal distribution of the skull-brain injuries among protected and unprotected road users.

Traffic injuries were most common during summer-time, with a peak in July, the traditional Swedish summer vacation month. 47% of the traffic victims came to the hospital during work-hours, here defined from 6 a.m. to 6 p.m., Monday to Friday. Thus more than 50% of the cases arrived when there was a minimum of staff.

Fig. 12 shows that skull-brain injuries were few compared to all injuries from traffic accidents. The fact that they were more common in hospitalized patients and very frequently the main injury causing hospitalization, indicates that they were regarded more serious than other injuries. The low relative consumption of hospital and intensive care days, is due to the very long average period of hospitalization for some other injuries, particularly orthopaedic and abdominal injuries. Six of the patients were referred to neurosurgical clinics.

The average period of hospitalization for skull-brain injuries (7.5 days) was shorter than that for all surgical patients (11.5 days) and was less than half of that of all traffic injured (16.0 days). The most common skull-brain injured patient with cerebral concussion was hospitalized only a few days for observation.

Conclusion: head injuries are the dominating cause of hospitalization of injuries in traffic accidents, but they have a short hospitalization time, are often part of multiple injuries and arrive more often when the staff is at a minimum.

Accidents in children

On account of the general physical characteristics of the head , children will show a different pattern of head injuries (Fig. 13), particularly movements of the child at falls and sudden velocity changes in traffic accidents will produce head injuries. Traffic injuries are more often hospitalized than domestic injuries and the greater difficulties to interprete the clinical picture also gives another epidemiological pattern than in adults.

It is very difficult to find a study where injuries among adults and children within the same region can be compared.

However, in a study from the Uppsala region, covering 1.4 mill. people or 1/6 of the population of Sweden, Thorson (1973) investigated traffic injuries 1965-66. It contains a follow-up examination 4-5 years after hospitalization, caused by accident. The total number was 2.500 patients of which a sample of 800 were interviewed and examined.

The table of head injuries among the categories of injured road users (Fig. 14a) shows a high percentage of children not only as cyclists and two-wheeled passengers, but also as car passengers.

Fig. 14b shows that head injuries often are reported as first or main diagnosis and thus considered serious; it occurs in children more often than in adults. As only hospitalized patients are reported the percentage of wounds is small. Among adults 18% of all late effects were due to head injuries compared to 34% among children. 18.5% of all head injuries among adults resulted in late sequele compared to 11% among children. Many factors such as social and working conditions in adults and anxiety of parents for children, etc. are involved.

Among the diagnoses "brain concussion" is quite dominating in these hospitalized cases (Fig. 14c).

In an urban district in north Sweden, Rune found the incidence of head injuries in children to be 1% for boys and 1/2% for girls each year. In a Swedish primary school population 15% of the children has sustained severe blows to the head and 9% had had cerebral symptoms.

Children´s head injuries occur mostly in summer-time and on Sundays. The relationship to the parents´ habits is evident from a recent study in the urban district of Newcastle, where Thursday is a payday and late-night-shoppingday with subsequent increase in frequency of head injuries in children.

In this investigation by Craft et al. 33% of head injuries occurred in traffic accidents, mostly pedestrians. These also had head injuries in half of the cases with multiple injuries, as the head in children always is the first or second body area struck by cars. However, in Newcastle 11 of the 16 accidents from cycling out of the 200 reported head injuries were probably due to the new highrise type of cycles. Dr Waller in Burlington found in a comparative study no relation between bike styles and distribution of severity of injuries in general but found also a preponderance for head injury with the high rise type.

Many parents place particularly their younger children in the rear seat. Siegel, Nahum and Appleby mentioned 1968 that in this location the younger unrestrained children sustained more severe injuries and head injuries while they struck the roof structures more frequently than the older children.

Many investigators have tried to find predisposing characteristics for head injuries and the Newcastle investigation showed that 18% of the left-handed children were injured compared with 4-8% in the population in general, also among children.

Naturally among children much interest has been focused to recovery and particularly mental recovery after injury. Of course, the proportions of sequelae will vary depending on the time for follow-up. Klonoff in Vancouver pointed out the importance of standardizing the elapsed time between trauma and re-examination. Complaints more often occurred in older children who also showed another pattern of disturbances, - headache, impaired memory, etc. - than the younger children - irritability and personality changes. Schaffer (1973) summarizes that for some unknown reason children with brain injury run an appreciably increased risk of developing a psychiatric disorder. It is not known if such injury influences the natural history of a given type of psychiatric disorder. Black et al. (1969) (cf. Schaffer) found that within a year after injury 31% of normal children developed behaviour abnormalities.

Owing to the difficulties of estimating the cause of frequently occurring accidents with the same persons many investigators have used the term "accident repeaters". Moreover, regarding the problem of accident proneness (cf. Mellbin 1972) Klonoff concluded 1971 one year after head injuries had occurred to the children that "it would be difficult to make inferences regarding accident proneness for the group as a whole without having comparable data for a control group". Rune 1969 found that accident proneness perhaps was present "only when the child's situation is complicated by a defective environment or previous psychic insufficiency".

INDIVIDUAL, COMMUNITY, MEDICAL CARE (Fig. 3)

The responsibilities of the individual regarding the pretraumatic conditions of the mind from irregular behaviour to alcohol habits are understood by all but the person concerned. Posttraumatic sequelae decreases his capacity as a road user.

Regarding the pretraumatic responsibility of the community: most efforts regarding prevention of injury have been directed to car occupants perhaps because improvements of instrument panel, windshield, steering column and front seat- and rear seat-safety belts are paid by the individual. These measures are indeed particularly apt to decrease the probability of head injury.

In a recent calculation in Sweden involving two million cars to hinder increase and even decrease the number of traffic victims, 20% reduction from 1973-76 could probably be obtained by such measures and laws and regulations to use them. Reduction in the number of injuries, but not of accidents would occur with little cost for the community. Further reductions in both would be very expensive.

However, as the insurance man Mr. Schlueter said 1970, only 2% of the disabling injuries accounted for 50% of the total costs and traffic accidents, especially if fatal, seemed to be cheap compared with other accidents, particularly "work accidents". I don't know if loss of life productivity, social securities for families left, etc. were accounted for, but such factors are an obvious reason for including the traffic problems in occupational medicine.

The responsibility of organized medical care is also a very big problem which has been dealt with at several neurosurgical congresses. Just one comment: a recent investigation of the need of neurosurgical care of head injuries in southwestern Sweden indicated that mobile neurosurgeons perhaps can be a good solution and also will increase interest in diagnosis of operable intracranial lesions.

INJURY PATTERN (Fig 3).

If we look at the scene of accident and the resulting injury pattern the so-called 1st collision with cars concerns the vehicle deformation and its index. However, the non-protected road users will make use of their physical and also biological tissue severity indexes already in the first collision.

The first body contact in the car occupants is often called the 2nd collision. Interior body damage has been called the 3rd collision.

The resulting injuries and their complications will constitute the bases for various kinds of injury scales, evaluating the severity of damage from different aspects.

Pedestrians may have their first head impact with the windshield after a first injury to the lower extremities. Next to single head injuries such a combination of head and extremity injuries was also most frequent in car occupants as found by Kihlberg (1970).

Extensive work has been performed regarding the interior safety of the car in relation to injury and head injury pattern of the occupants. Ejection fatalities will perhaps belong to the past but the front seat passenger is still the most injured person. Voigt in Sweden has pointed out that the steering wheel can cause face, neck and head injuries to drivers when they slip downwards in frontal collisions. At cadaver experiments with one type of air bag "protection" injuries could occur to the brain surface, subdural space and the neck (Voigt et al. 1973).

Nahum & Siegel has noted that death rates have proved to be insensitive to some major changes in injury causation. Recently a Swedish car factory (Volvo 1973) has calculated only a 20% decrease of injuries with their expensive so-called "Experimental safety vehicle". The reduction was even less when compared with occupants using their now available safety measures in the standard cars. A Swedish insurance company (Folksam 1972) has also found a decrease from 40% to 27% in deaths and severe injuries, particularly head injuries, when seat belts were used, in spite of higher collision speeds.

Less work has been done to prevent and modify causation of injuries of non-protected road users. In certain collisions between lorries with the modern type of front cabin as well as in cars driving into front or rear of big lorries the occupants can be regarded as non-protected, particularly as regards head injuries (cf. Gissane et al. 1973).

If we turn from this tremendous field of prevention of injuries to the area of responsibilities of *medical care*, there is first the problem of treatment at the accident scene and during transportation and then the evaluation of the injury itself.

In a series from Czecho-Slovakia of 2.000 autopsied cases, of whom 63% died from CNS lesions, 49% died at the traffic accident scene, 6% during transportation and 45% in hospital (Kirschner). 25% of the two last groups had mass aspiration of the airways. In 500 fatalities of car occupants (Hossack 1972) had such aspiration and no sign of serious injury, but location and time after death was not reported. Gissane found that 31% were killed instantly and another 26% within twelve hours in an autopsy material of 350 traffic victims (1963).

In reports concerning the acute head injuries a neurosurgeon is surprised how many trivial face wounds are included under this heading. In the case of skull-brain injuries he is also startled over the monotonous reports of skull fractures; these cannot be accurate measures of their frequency in survivors and give no information of the severity of cerebral damage. Its use as a diagnostic finding is another matter.

However, important difficulties begin when evaluating the distribution and changing pattern of intracranial injuries.

Severity of injuries is the most difficult and important factor to estimate. This applies also to head injuries which indeed can be seen from all the attempts to construct *injury scales* in spite of inadequate basis; varying nomenclature and content in the diagnoses is used even by neurosurgeons. Also statistical evaluation and given percentages of permitted risk within various scale classes is different, - if they are evaluated at all. Head injuries in the AMA-abbreviated injury scale are in general regarded severe and life-threatening if unconsciousness occurs for more than 15 minutes and critical with coma of more than 24 hours.

In a review in our clinic of about 500 patients who died without regaining consciousness or with posttraumatic coma of more than 12 hours and no expansive complications the mortality was 34.5%. The primary cerebral injury accounted for 28.5% and the extracranial causes of death occurred almost exclusively in patients over 50 years of age, in the older age groups such causes raised the mortality to 60%. The median survival time was 17.5 hours and the median coma

duration (at which 50% of the cases regained consciousness) was 32.3 hours (Carlsson et al. 1968).
In a rehabilitation center in California (Brink et al. 1970) 87% of 52 children, comatose more than one week, could achieve independence in ambulation and self care.

It seems as the classification in the single case must be related to simple practical conditions and function of the whole man: ability to survive at the roadside without help for some time. Ability to withstand transportation for one hour. Risk of developing critical complications before treatment is available, etc. The environment will influence such classification. During conditions of catastrophy and war inability to walk, epileptic fits, etc. will be regarded as life-threatening.

Statistical work on comparable material must be the basis for evaluation of survival and disability with the various well defined lesions, treatment, etc.
In general the neurosurgeon has more experience of evaluating severity of operable intracranial lesions related to available adequate treatment.

During the years 1956-1967 Jamieson in Brisbane paid particular attention to the epidemiology of the various intracranial injuries.

Depressed fracture of the skull occurred in traffic accidents mostly in the first, second and third decade in simple fractures and in a little higher ages in the compound fractures. This could be expected because of the properties of the young skull. Medical care could perhaps be improved in simple fractures with complicating subdural hematomas. In general the mortality was highest in the first six hours after the accident and almost twice as high in traffic injuries than in other injuries. This was probably caused by a higher percentage of accompanying brain damage with compound, severe fractures, now occurring also in children. The mortality is increasing.

Extradural hematomas occurred most frequently in the younger decades. The temporobasal hematomas amounted to 70%. The hematomas often occurred in less violent accidents than traffic accidents. However, associated intradural lesions accounted for the main part of the deaths, almost half of them occurring within 12 hours. Jamieson found that the outstanding avoidable cause of death was undue delay in diagnosis and treatment, although the mortality rate seemed to decrease.

Contrary to this his 553 patients with subdural hematomas has not shown any improvement in mortality rates. Associated brain damage in the so-called complicated hematomas dominating in the more violent traffic accidents and extracranial complications in the simple hematomas in the older cases may account for this. Also the incidence of patients needing permanent hospital care seems to increase in this group.

One interesting finding is that simple subdural hematomas were found in mild injury, old persons, often unknown impact site or with ipsilateral trauma. Complicated hematomas were found in severe traffic accidents, in persons aged 20-50 years and with more equal distribution of ipsi- and contralateral blows, but occipital impact sites were much more frequent than the frontal.

However, of the 291 combined brain lacerations and contusions almost 70% were considered "contre-coup", axial or lateral. Talalla and Morin found recently mostly axial and occipital blows in 100 acute subdural hematomas.

Finally, intracerebral hematomas were contre-coup in 65% with maximum incidence in the third to sixth decade. They were found only in 63 cases but in a personal communication Jamieson confirmed our own impression that these focal expansive contusions or hematomas nowadays are more common, particularly in the temporal and frontal lobes than the extradural hematomas. Previously he included lacerations with intracerebral clots and so-called exploded temporal poles with a layer of subdural blood in the group of complicated subdural hematomas.

The interest of this symposium in epidemiology is of course also focused upon the possibility of contributions to theories of mechanisms of head injuries. For instance the mentioned simple and the complicated subdural hematomas may have different genesis.

In our clinic 104 temporal lobe expansive contusions were studied a few years ago. The purpose was to observe if influence of biological factors could elucidate the genesis of such contusions. However, increasing severity of similar types of violence may precipitate other mechanisms and other types of intracranial injuries, particularly as regards the primary severe brain lesions. Thus these cases were selected and the focal contusion was the main lesion.

The relations between frequency of categories of road users to various ages, impact sites and lesions were first studied. Then the three last mentioned factors were correlated. The study of the type of road users was to some degree also a study of nature and severity of impacts (Fig. 15).

The study showed that the categories of road users had the expected distribution through the ages, that falls to the ground level caused most of the occipital impacts, that such falls in non-traffic accidents and accidents to pedestrians or bicyclists hit by car caused most of the temporal lobe contusions, that temporal lobe contusions occurred mostly with occipital or lateral impact and finally that there was a sharp rise in the incidence of temporal lobe contusions above the age of 30 years (Fig. 16a-b).

These findings were correlated with the wellknown fact that the rigidity of the skull increases at the end of the third decade with a final closure of the sutures of the skull. This would mean that the velocity change of the skull at impact and peak accelerations, irrespective of what type, translational or rotational, could be a contributing factor.

The interpretation of the mechanics behind cerebral post-traumatic symptoms of different severity must always consider the possibility of different mechanisms involved with varying severity of impact and of lesions. It is also wellknown that similar symptoms can be caused from damage of various locations. There is need to stress the importance of cautiousness when applying a theory for the explanation of different intracranial injuries. Some years ago we proposed a combination of factors probably eliciting such injuries (Fig. 17). An example: a so-called focal "contre-coup" lesion may occur, irrespective of translational or rotational acceleration genesis of a negative contre-coup pressure, only when local volume changes of the skull are added through its deformation or oscillation.

SUBJECTS FOR IMPROVEMENT

Improvements in the reporting, prevention and modification of accident and injury pattern as well as in medical care will take considerable time. Eliciting changes in the action of individuals and communities will also be difficult.

However, among the medical objects where improvement of evaluation immediately can be performed are those, where nomenclature of diagnosis is questionable. "Head trauma" is a better semantic diagnosis than over-representation of cerebral concussion, when the patient is hospitalized only for observation of possible complications.

Symptomatic diagnoses are better than false application of non-verified pathoanatomical nomenclature.

The importance of the primary damage must be recognized and secondary minor lesions as a few mm of subdural hematoma should not be used as a main diagnosis.

Perhaps the international committee on neurotraumatology can solve such practical problems aimed for better interpretation of head injury epidemiology.

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TRAFFIC ACCIDENTS

Approaches

Statistics-Analysis

Generally descriptive What has happened in the region	Descriptive What happens at the accident	Responsibilities What to do in the region and accident
Host Agent-Vector Environment	Precrash Crash Postcrash	Individual Community Hospital

Figure 1

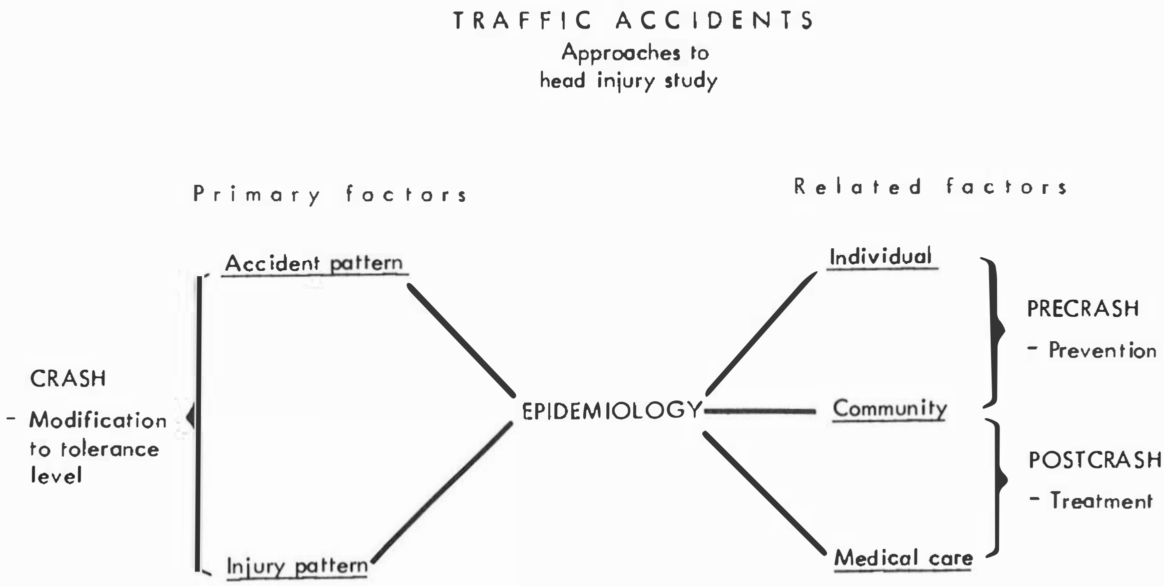


Figure 2

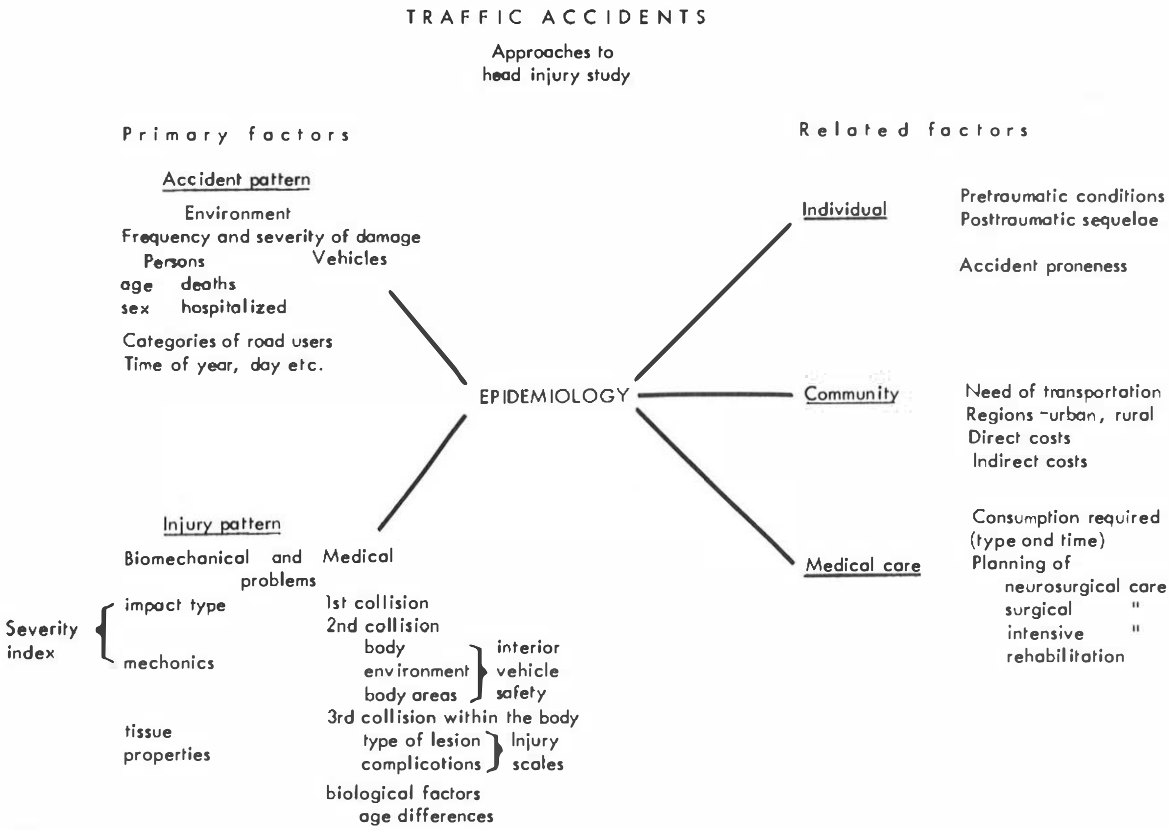
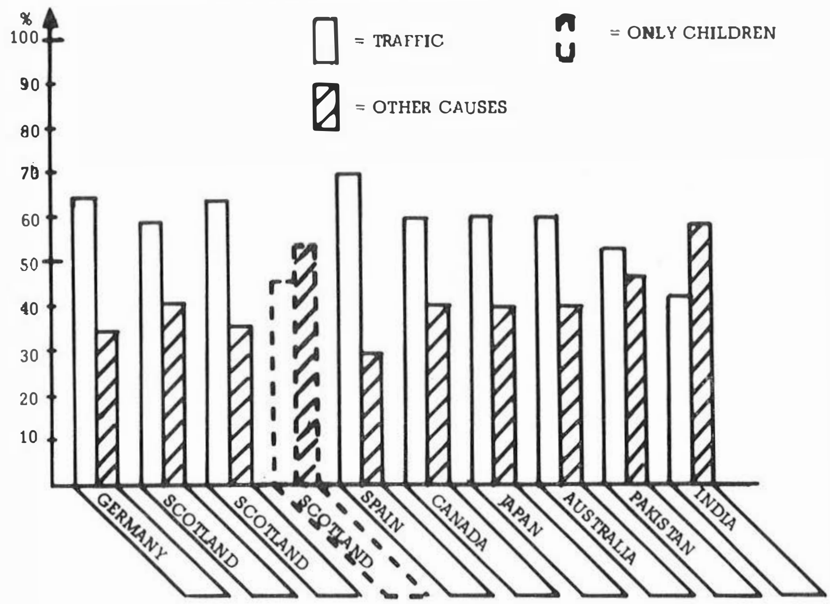

TRAFFIC ACCIDENTS
Approaches to head injury study
Primary factors
Accident pattern
Environment
Frequency and severity of damage
Persons
Vehicles
age
deaths
sex
hospitalized
Categories of road users
Time of year, day etc.
EPIDEMIOLOGY
Injury pattern
Biomechanical and Medical problems
Severity index
impact type
mechanics
tissue properties
1st collision
2nd collision
body
environment
body areas
interior vehicle safety
3rd collision within the body
type of lesion
complications
Injury scales
biological factors
age differences
Related factors
Individual
Pretraumatic conditions
Posttraumatic sequelae
Accident proneness
Community
Need of transportation
Regions -urban, rural
Direct costs
Indirect costs
Medical care
Consumption required (type and time)
Planning of
neurosurgical care
surgical "
intensive "
rehabilitation

Figure 3

CAUSES OF HEAD INJURIES IN DIFFERENT COUNTRIES

COUNTRY	REFERENCES	TOTAL NUMBER	TRAFFIC %	OTHER CAUSES %	TYPE OF MATERIAL
GERMANY	Gögler 1952-58	5431	65	35	Hospital
SCOTLAND	Hpay 1965-67	3329	59	41	Hospital
SCOTLAND	Maloney 1962-66	173	64	36	Autopsy
SCOTLAND	Shaw 1957-66 children 13 years and under	554	46	54	Hospital
SPAIN	Arjona, Pastrana 1969 (about 1966-69)	266	70	30	Hospital
CANADA	Clifford Richardson 1964	400	60	40	Hospital
JAPAN	Sano 1964	(?)	60	40	Autopsy
AUSTRALIA	Jamieson	(?)	60	40	Hospital
PAKISTAN	Jooma 1960-64	1062	53	47	Hospital
INDIA	Ramamurthi	2000	42	58	Hospital



CAUSES OF HEAD INJURIES IN DIFFERENT COUNTRIES

Figure 4

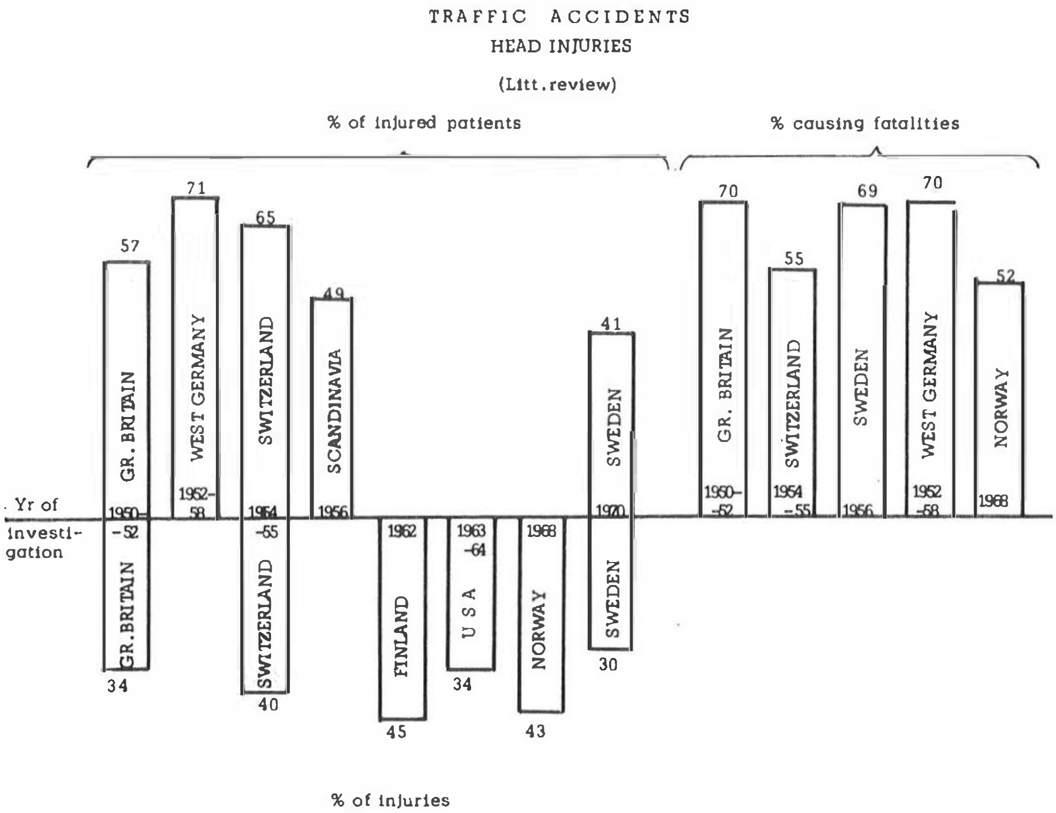


Figure 5

TRAFFIC ACCIDENTS

Distribution of
HEAD INJURY DIAGNOSES

AUTHOR TYPE OF MATERIAL	YEAR OF INVEST:	FRACTURES			INTRACRANIAL INJURIES			WOUNDS		
		SKULL NO.	FACE NO.	%	CER. CONCUSS NO.	OTHER NO.	%	SKULL NO.	FACE NO.	%
THORSSON x) SWEDEN	1965 - 1966	6	18	8	164	6	56	11	36	15
BØ xx) NORWAY	1968	155	118	16	946	143	45	456	580	43
HANSSON xx) SWEDEN	1970	14	23	10	105	15	32	157		42

x) Hospitalized patients
xx) Hospitalized and out patients

Figure 6

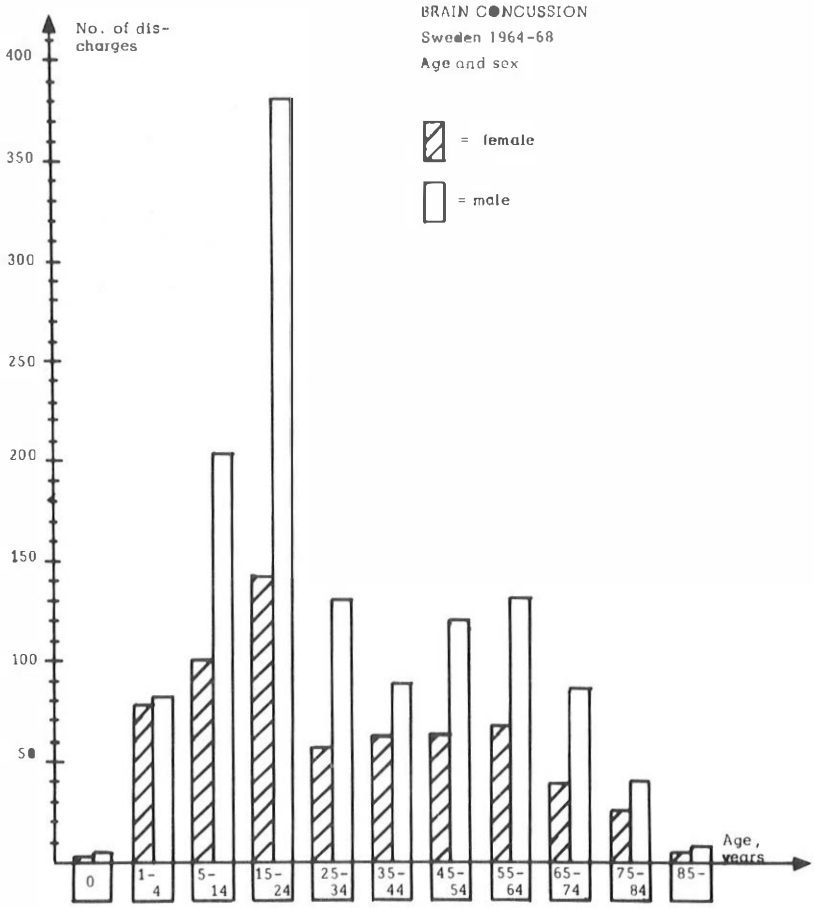


Figure 7

AGE AND SEX DISTRIBUTION OF 173 CASES OF FATAL HEAD INJURY
(Maloney and Whatmore 1962-1968)

SEX	AGE IN DECADES								TOTAL
	1	2	3	4	5	6	7	8	
M+F	13	18	18	18	15	29	31	31	173
M : F	-	5.0:1	3.5:1	8.0:1	6.5:1	2.6:1	1.8:1	3.4:1	3.7:1

Figure 8

TRAFFIC ACCIDENTS

HEAD INJURIES IN

DIFFERENT CATEGORIES OF ROAD USERS

(Litt. review)

	HOSPITAL MATERIAL x)		AUTOPSY xx) MATERIAL
CATEGORY of ROAD USER	% of DIAGNOSES RANGE	% of PATIENTS RANGE	% HEAD INJ. as CAUSE of DEATH
CARS	40 - 49	66 - 79	42 ; 30
BUS and/or LORRIES	43	49 - 64	-
MOTOR CYCLISTS	32 - 42	41 - 70	85 ; 69
MOPEDISTS	40	51 - 78	83
BICYCLISTS	35 - 51	43 - 82	88 ; 71
PEDESTRIANS	32 - 46	50 - 79	66 ; 56

x) Aston & Perkins (1954)
Bø (1972)
Gögler (1962)
Hansson (to be published)
Slätis (1967)
Wulff (1957)

xx) Slätis (1962)
Wahlgren (1957)

Figure 9

HEAD INJURIES IN TRAFFIC ACCIDENTS

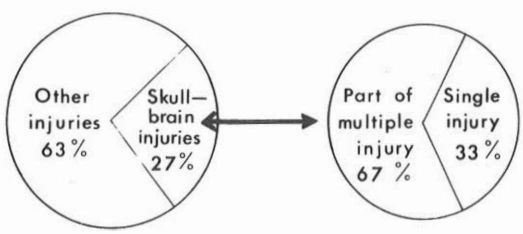
(HANSSON 1973)

	Number	Percent
Skull-brain injuries	134	36
Facial fractures	23	6
Wounds	157	42
Other	60	16
TOTAL	374	100

Figure 10

MULTIPLE INJURIES IN TRAFFIC VICTIMS

SKULL - BRAIN INJURIES IN TRAFFIC VICTIMS



(HANSSON 1973)

Figure 11

SKULL- BRAIN INJURIES IN TRAFFIC ACCIDENTS.

(HANSSON 1973)

	Percentage skull-brain injuries
All injuries	13
Hospitalized patients: All injuries	30
Hospitalized patients: Main injury	41
Hospital days	18
Intensive care days	24

Figure 12

SKULL - BRAIN INJURIES IN CHILDREN
COMPARED TO ADULTS

Influence on epidemiology from

Physical features	Clinical implications
Different mass relation head to neck-body	often multiple injuries more subdural lesions
Anterior skull base less cavities	less focal complications
Calvarium-shell of thin bones and fibrous tissue (fontanel)	often indentations (focal symptoms)

Epidemiological features
favouring occurrence of head injuries

Age	Accident type
Up to 2 years of age	Falls
2-7 "	"Pedestrians" and falls
5-14 "	Cyclists
14-16-18 "	Mopeds and motorcycles

Clinical features

Prognostic - Epidemiologic
interpretation

Severity?

Frequently changes in conscious level " early focal epileptic attacks " hyperthermia and respiratory changes " extension rigidity	more benign course than in adults

Figure 13

TRAFFIC ACCIDENTS - HEAD INJURIES

(Uppsala 1965 - 66)
(Thorson)

% of injured road users

	Pedestr.	Cyclists Single	Cyclists Collision	Moped MC	Car driver	Car front p.	Car rear p.
Adults	42 %	39	29	27-32	36	41	39
Children 0-14 years	45 %	51		42	49		

a

in hospitalized patients

	Face Acute – percentages of all body injuries: Total	Fract.	Wounds	Head Acute: Total	Main diagn.
Adults (426 pats)	11	5	6	36 (of 655 diagn.)	48 (of 426 pats)
Children (426 pats)	10	3	7	48 (of 516 diagn.)	56 (of 401 pats)

b

- type of lesions

	Diagn. Total nr	per cent of diagnoses: Fract.	Concuss	Other intra-cran. lesions	Misc.	Wounds
Adults	237	3	69 (164 diagn)	3	21	5
Children	248	4,8	74,2 (184 diagn)	12,5	6,5	2

c

Figure 14

Model for epidemiologic analysis

of head injuries

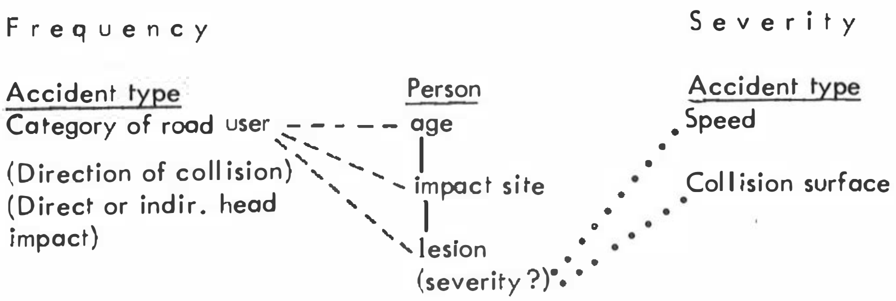


Figure 15

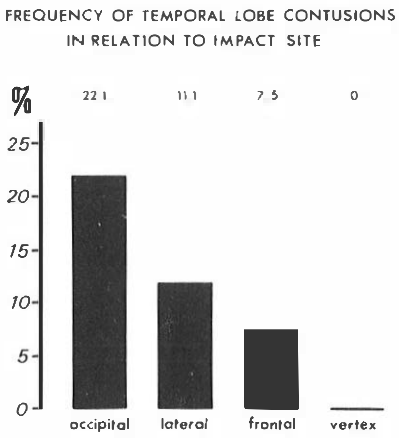


Figure 16a

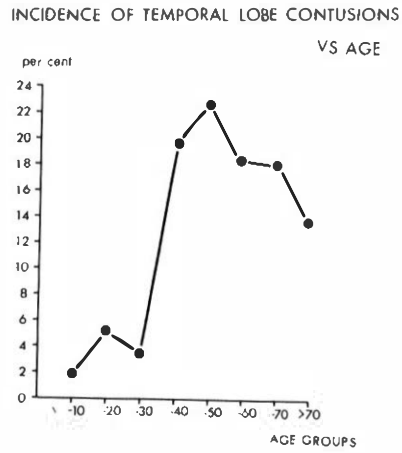


Figure 16b

HEAD INJURY

clinical - mechanical correlations

LESIONS	Skull movements		Movements	SKULL DEFORMATION
	TRANSLATIONAL Intracran. press. changes	ROTATIONAL Skull-brain movem. diff.	HEAD - CERV.SPINE	Intracran. volume changes
Brain concussion symptoms	+	+	+	-
Brain stem injury	+	+	+	-
Focal intracerebral contusion	+		-	+
Brain surface hemorrhage, contusion	-	+	-	+
Subdural hematoma x)	-	+	-	-
Malignant brain edema: contusions, lesions of sinuses and subarachn. veins		+	-	-
Epidural hematoma	-	-	-	+

x) may occur secondarily to contusion
\+ present
\- absent

Figure 17