TRAFFIC ACCIDENT REGISTRATION AND ANALYSIS IN GÖTEBORG

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Abstract

A computor-based information system for traffic accident analysis has been used in Göteborg since 1971. This system processes accident and environment data from police reports and traffic measurements and facilitates continuous traffic regulations and road improvements. The number of traffic accidents per year in Göteborg decreased from 6,000 to 3,900 during 1971-1980. The calculated profitability for traffic safety investments was 18%. If this corresponds to a reduction of the real costs of all traffic accidents is not clear.

A complementary registration of traffic accident casualties was started at the emergency hospitals in 1979. The purpose was improved injury classification and decreased number of not reported accidents. This hospital-based primary registration was expanded to include the medical and social consequences for patients injured in traffic accidents during three months in 1979. The time in hospital, the hospital costs, the time on sick-leave and compensations from the health insurance office indicated the accident outcome. Pedestrian accidents were by far the most important category according to this analysis.

Improved traffic safety depends among other things on reliable traffic and accident data. A more differentiated injury classification should improve the accident analysis and justify a continued use of this system. Medical information can be used in a more precise way to achieve this as indicated in this study.

Introduction

Swedish official statistics on traffic accidents are based on police reports. These include traffic, road and vehicle data as well as injury classifications according to the definitions in Table 1. The total costs for different injury severities have been calculated from expenses for medical care, estimated loss of future production caused by the permanent disability, costs for administration and material damage (Johnsson E, 1974).

Table 1 Injury severity and costs of traffic accidents according to Swedish official statistics in 1979

Injury severity	Definition	Costs (Sw.Cr. * 10^6)
Fatality	Dead within 30 days as a result of the accident	0.9
Serious injury	Fracture, crush injury, severe cut or laceration, cerebral concussion, internal lesion or any other lesion which causes detention at hospital	0.1
Slight injury	Any other injury	0.02
Material damage	No injury	0.005

Investments for improved traffic safety should be proportional to the total costs for traffic accidents. Measures for accident prevention and injury mitigation should be evaluated in cost-benefit analysis by national and local road traffic authorities. Public accident data are not qualified for that purpose. There is a large number of accidents not reported, varying according to the injury severity, the type of accident, and the accident place (Hansson 1974, Tolagen 1977). The injury severity is also incorrectly reported in a number of cases, which is not neglectable. Costs for human injuries are to some extent imaginary. The absolute costs indicated in Table 1 are estimated mean values for a large number of accident types and outcomes not related to the age of the injured or to any other accident variable. The measure of the accident outcome should be more differentiated corresponding to this variation. A relative measure for accident outcomes could be a basis for this differentiation.

A computerized information system for traffic accident analysis (NPK-TRAFO) has been used in Göteborg since 1971. This system was intended to store and process accident data for a defined region to describe the accident development, analyse the cause of the accidents, especially traffic environment factors, and to facilitate priority judgements for traffic safety investments on the road network.

A registration of traffic accident casualties at the hospitals in Göteborg was introduced in 1979. The primary intention was to complete the official accident outcome data and decrease the number of not reported accidents. A further intention was to classify the accident outcomes for different categories of road users and ages.

Scope

The aim of this study is

I To evaluate the method for traffic accident analysis in Göteborg.

II To investigate the reliability of police-reports and to estimate correction factors for different categories of road users by which the number of casualties reported by the police could be transformed to represent the real ones.

III To calculate the relative medical and social costs for different categories of road users in traffic accidents.

Methods and material

The computerized analysis is based on official police reports and local road traffic data. It includes the type and time of accident, the place of accident defined in a regional and local geographic reference system, and the characteristics of the local road traffic environment. The disturbance of the normal traffic flow preceding the accident indicates the possible accident cause. The injury severity reported by the police indicates the accident outcome.

The road network is divided into a **main network** which includes national, primary, and secondary roads, a **local network** including feeder roads and local streets and **other places** including parking places etc. The greater part of the accidents occur on the main road network. The accidents can be well located on the main network. On the local network and other places the accidents can be located to districts only.

The accident development was analysed with linear regression during the period.

I Measure effect analysis

The effect of rebuildings and of traffic regulations carried out during 1974-1976 was studied in some places of the road network. The number of accidents before and after the changes was subtracted and the corresponding injury cost difference was compared to the investments. Corrections were made for the average traffic development in the region and for the number of accidents not known by the police. The real number of road-users killed and injured was estimated using correction factors recommended by the Swedish National Road Administration: 1.06 for killed, 2.13 for seriously injured, 5.9 for slightly injured. The correction factor for accidents without human injuries was 8.0.

II Correction factors for police-reported accidents in Göteborg

The number of accidents during 1981 as reported by the police and the number of accidents as reported by the hospitals were compared. A correction factor by which the real number of casualties could be estimated from the police data is

$c = 1 + h/p$, where

h is the number of accidents, not known by the police, reported by the hospitals and **p** is the number of accidents reported by the police. An unknown number of accidents were not reported by any of these sources. This number was neglected. Correction factors were calculated for different road user categories.

III Accident outcome analysis

The individual accident outcome is indicated by one or several of the **accident outcome variables:**

v_1 = time in hospital
v_2 = time on sick-leave
v_3 = hospital costs
v_4 = health insurance office compensations

A fatality could be given an outcome corresponding to hospital care during the rest of the expected lifetime. In this study the actual time and costs were used.

The median values of v_1, v_2, v_3, and v_4 for all seven categories of road users **i** are the **accident outcome parameters** $p_{i,1}$, $p_{i,2}$, $p_{i,3}$, and $p_{i,4}$, respectively.

A **relative accident outcome factor** $r_{i,j}$ defined as

(1) $r_{i,j} = p_{i,j}/p_{\text{car driver},j}$ $(j = 1, \ldots, 4)$

is calculated for all categories **i**, thus giving the ratio between the median time in hospital for road users of category **i** and the car drivers and the corresponding ratios for the three other accident outcome parameters.

The mean value of these relative factors

(2) $m_i = 0.25 \cdot \sum_{j=1}^{4} r_{i,j}$ $(i = 1, \ldots, 7)$

is the **mean relative accident outcome factor.** This factor relates the median accident outcome for road users of category **i** to the outcome of injured car drivers. This factor expressed in per cent of the sum of the factors for all categories is the **standardized accident outcome factor** o_i.

The relative demands for medical and social care for all road users of categori **i** could be expressed by the formula

(3) $d_i = 100 \cdot f_i \cdot o_i / \sum_{n=1}^{7} (f_n \cdot o_n)$, in which

d_i indicates the **relative demands** for all road users of category **i** (per cent)

f_i (f_n) is the **relative frequency** by which road users of categori **i** (**n**) are admitted to hospital (per cent)

o_i (o_n) is the **standardized accident outcome factor** indicating the relative demands for one road user of category **i** (**n**) admitted to hospital (per cent).

If the costs for out-patients are much lower than those for in-patients the outcome factor o_i could be calculated from the in-patients data only.

In this study the accident outcome was estimated using formula (3) for hospital in-patients admitted during March, October, and November, 1979. During these months personal resources made a follow-up possible.

Results

Accident development

Data from 50,000 accidents were stored and processed in the computer during 1971-1980. The traffic intensity increased by 22% but the total number of accidents per year decreased from 6,000 to 3,900 (35%) during this period (Fig. 1). Human injuries occurred at about 20% of the accidents. A fuel rationing occurred in 1974. This decreased the traffic intensity and reduced the total number of accidents during this year but not the number of accidents with human injuries.

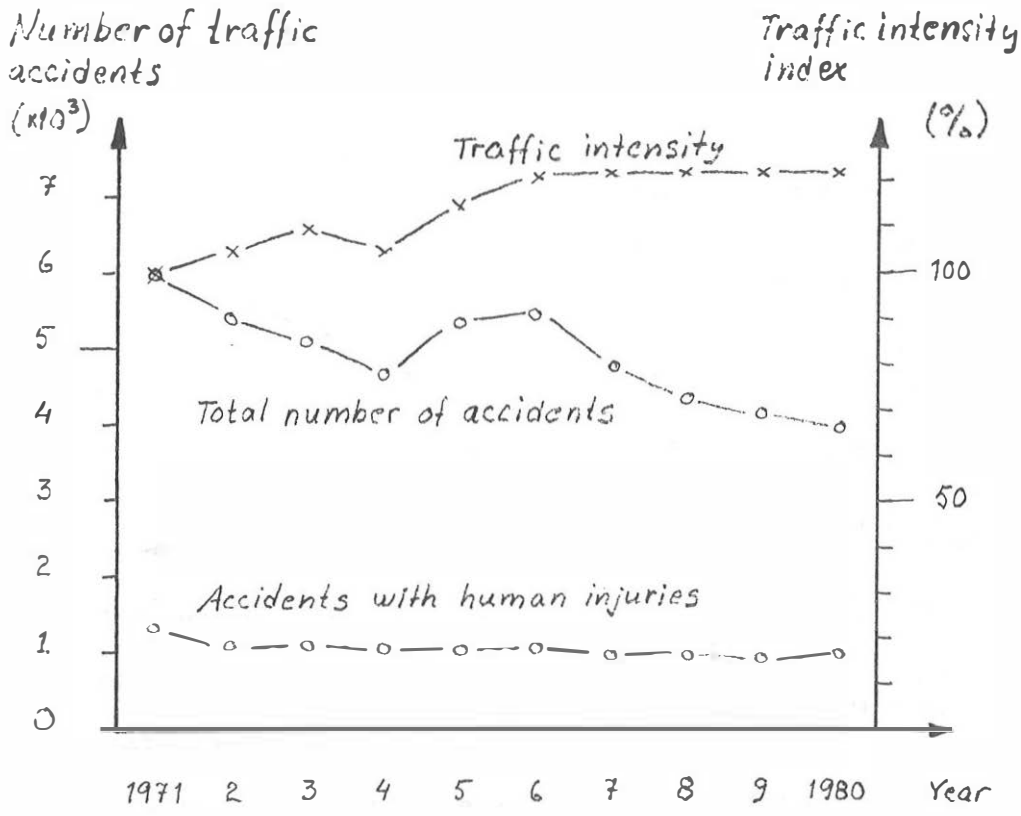

Figure 1 Number of traffic accidents and traffic intensity index in Göteborg during 1971-1980 according to official statistics.

The number of injured decreased by 28%, equally for seriously and slightly injured. The number of fatalities decreased slightly but the difference was not significant (Fig. 2).

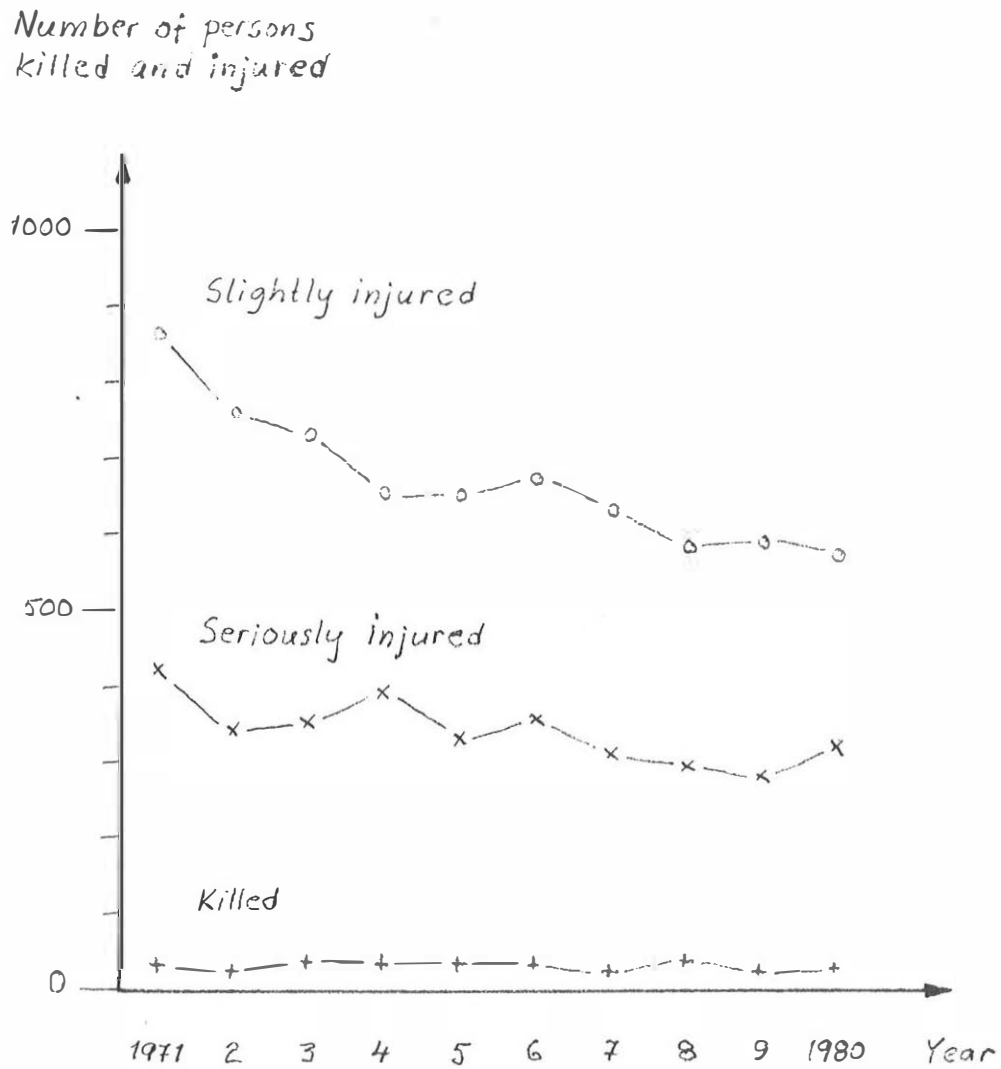

Figure 2 Number of persons killed and injured in traffic accidents in Göteborg during 1971-80, according to official statistics.

The number of persons killed and injured exceeded the number of accidents with human injuries by 20%.

The number of children (<17 years) killed and injured during this period was reduced by 33%. The number of elders (>64 years) killed and injured was reduced by 15%.

Approximately 50% of all road users killed in traffic accidents were pedestrians. Pedestrians more often were seriously injured or killed than slightly injured in traffic accidents (Fig. 3). The number of pedestrian accidents decreased less during the later part of the period.

Figure 3 Number of pedestrians killed and injured in traffic accidents in Göteborg during 1971-80 according to official statistics.

I Effect of rebuildings and traffic regulations.

Approximately 80% of the accidents occurred on the main network, 15% on the local network and 5% in the other places. The effect of road rebuildings and traffic regulations was studied in 9 and 450 places, respectively. The number of traffic accidents before and after the changes was reduced by 44% (Table 2).

Table 2 Number of accidents before and after rebuildings and traffic regulations in Göteborg during 1974-1976 according to official statistics .

Measure	Number of accidents per year Before	After	Reduction	%
Rebuildings	572	319	253	44
Regulations	468	267	201	43
Total	1,040	586	454	44

The average reduction in other parts of the road network was 7%.

The annual accident cost reduction was 24 · 10^6 Sw.Cr. on eight of the rebuilt places corresponding to 14% of the investments. On the ninth place both traffic intensity and number of accidents increased. The calculated profitability for all the investigated traffic safety investments was 18%.

II Police-reported accidents: correction factors and injury severity.

The correction factors, by which the real number of injured can be estimated from the police reports, are presented in Table 3 for some road user categories and injury severities. These factors were based on hospital and police data during July-December 1981. The correction factor for killed was 1.0.

Table 3 Traffic accidents in Göteborg, during July-December 1981. Percentage injured reported by the police and correction factors for calculation of the real number of injured for different road user categories and injury severities.

Road user category	Total number injured	Number reported by police	Accident outcome: Serious injuries Per cent reported	Serious injuries Correction factor	Slight injuries Per cent reported	Slight injuries Correction factor
Pedestrians	163	114	85	1.2	53	1.9
Bicyclists	234	80	46	2.2	31	3.3
Moped drivers	72	32	65	1.5	33	3.1
Car drivers	284	224	78	1.3	80	1.3
Car passengers	149	109	80	1.3	69	1.4
Others	117	74	78	1.3	56	1.8
Total	1,019	633	73	1.4	57	1.8

The average percentage police-reported casualties was 62% and the average correction factor 1.6. Twenty-two of 158 patients (14%) reported by the police as seriously injured were treated as out-patients. Nine of 185 (5%) reported as slightly injured were treated as in-patients (Table 4).

Table 4 Injury severity in traffic accidents in Göteborg according to police reports and hospital data, during July-December 1981.

According to police reports	According to hospital data				
	Dead	In-patient	Out-patient	Not reported	Total
Fatality	12	0	0	6 [1)]	18
Serious injury	0	136	22	53	211
Slight injury	0	9	176	219	404
Not reported	0	77	309	-	386
Total	12	222	507	278	1,019

1) Not admitted to emergency department.

Approximately 10% of the patients were admitted to hospitals in the neighbouring cities or to private medical care. Approximately 20% of the patients did not need medical care.

III Accident outcome

Relative admission frequency

During March, October, and November 1979, 354 patients injured in traffic accidents were admitted to hospital. Two of these died because of the injuries. Table 5 shows the number of in- and out-patients and the road user categories they represent. Pedestrians and car drivers were most frequently admitted, each corresponding to 27% of the total number. Thirty-five per cent of all injured were treated as in-patients. This figure ranged from 20% for car passengers to 54% for pedestrians.

Standardized accident outcome factor

Table 6 demonstrates the median values of the time in hospital, the hospital costs, the time on sick-leave and the payments from the health insurance office for in-patients injured in traffic accidents during these periods. These represent the accident outcome parameters. Car drivers show the least serious accident outcome, motor-cycle drivers the most serious. Table 6 also indicates the standardized accident outcome factors.

Table 5 Patients injured in traffic accidents admitted to hospital during March, October, and November 1979. Type of medical care.

Road user	Type of medical care				Total number admitted	
	Out-patients		In-patients			
category	Total	%	Total	%	Total	%
Pedestrians	45	46	52	54	97	27
Bicyclists	19	59	13	41	32	9
Moped drivers	18	67	9	33	27	8
Motor-cyclists	7	78	2	22	9	3
Car drivers	66	69	29	31	95	27
Car passengers	63	80	16	20	79	22
Others	13	87	2	13	15	4
Total	231	65	123	35	354	100

Table 6 Hospital in-patients injured in traffic accidents admitted during March, October, and November 1979. Median values of time in hospital, hospital costs, time on sick-leave, and payments from health insurance office. Standardized accident outcome factors.

Road user category	Hospital median		Health insurance median		Standardized accident outcome factor
	Time	Costs	Time	Costs	
	(Days)	(Sw.Cr.·10^3)	(Days)	(Sw.Cr.·10^3)	(%)
Pedestrians	7	11	130	13	23
Bicyclists	5	4	100	7	12
Moped drivers	7	8	300(2)	35(2)	19
Motor-cyclists	20(2)	25(2)	65(1)	4(1)	33
Car drivers	1	1	25	1	3
Car passengers	2	2	20	1	4
Others	2(2)	2(2)	35(2)	4(2)	6
					100

(1) = one case
(2) = two cases

Relative expenses

The relative expenses for injured road users are illustrated in Fig. 4. The horisontal axis shows the relative admission frequency for different road user categories given in Table 5. The vertical axis shows the standardized accident outcome factors given in Table 6. The area of a certain part in this diagram is proportional to the expenses for all members of that road user category. This is calculated by the formula (3) and expressed in per cent of all expenses for injured road users which corresponds to the sum of all areas. Pedestrians account for 53% of the total expenses for injured road users according to this analysis.

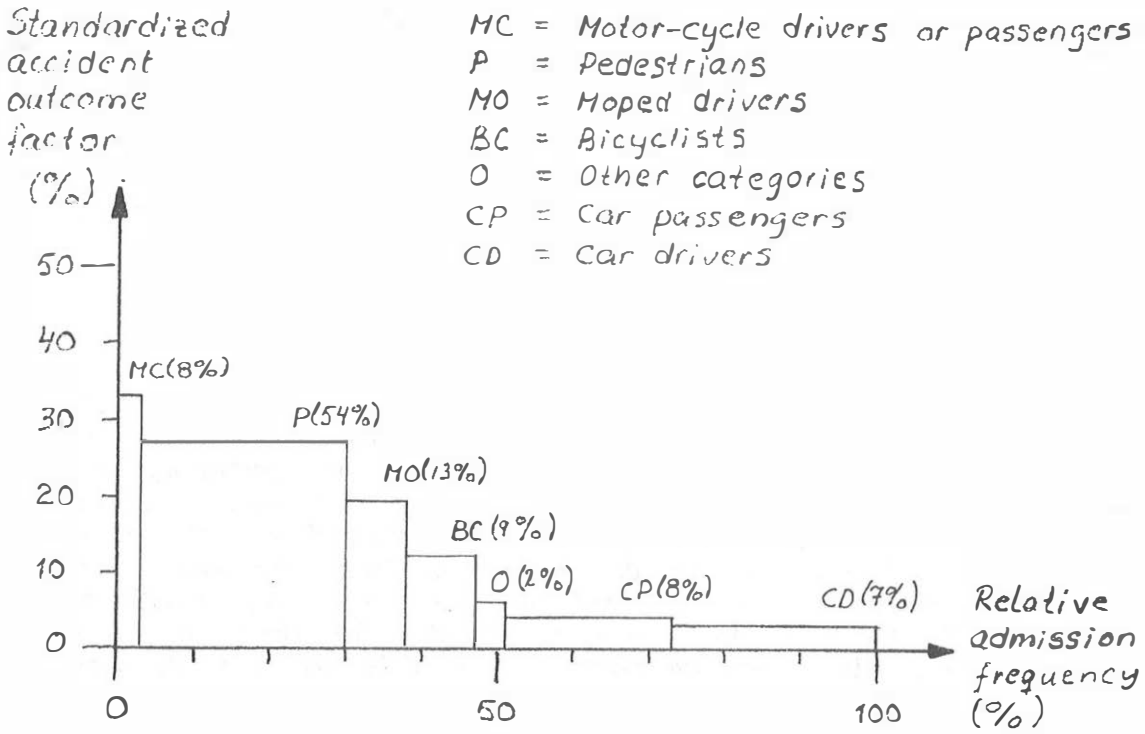

Fig 4 Relative expenses for all injured road users calculated from the relative admission frequency and the standardized accident outcome factor.

Hospital out-patients

Sixty-five per cent (231) of all injured left the hospital on the day of admission. Fifteen were children and 23 elders not registrated at the health insurance office. The mean cost for examination and treatment was 200 Sw.Cr. Ninety-one patients received payments from the health insurance office. The sum of these payments was 139,000 Sw.Cr. in total.

Discussion

According to official statistics the annual number of persons killed and injured in traffic accidents in Sweden decreased during 1971-1980 by 30% and 12%, respectively. Seat belts, helmets, speed limits, mandatory dipped head lights in the daytime, traffic regulations and safer roads and traffic environments are all factors being credited for this favourable development. The isolated effect of any accident-preventing or injury-mitigating factor could not be confirmed so easily.

The total number of traffic accidents in Göteborg decreased by 35% during 1971-1980 (Fig.1). There was a 28 per cent reduction of injured persons but only a slight reduction of fatalities in traffic accidents (Fig.2). The estimated annual accident cost reduction was 24 . 10^6 Sw.Cr. in the rebuilt places. The calculated profitability for all the investigated traffic safety investments was 18%. If this corresponds to a reduction of the real costs of all traffic accidents including the growing number of isolated bicycle accidents and the large number of commuting accidents with no vehicles involved is not clear (Forsström 1982). The cost-benefit analysis of road rebuildings and traffic regulations was based on the average costs for traffic accidents (Table 1) and the correction factors for police-reported accidents in Sweden: 1.06 for killed, 2.13 for seriously injured, 5.9 for slightly injured and 8.0 for accidents without human injuries.

Correction factors used to estimate the real number of accidents in Göteborg from the number reported by the police should be 1.0 for killed, 1.4 for seriously injured, and 1.8 for slightly injured. The correction factors for different road user categories are presented in Table 3. An unknown number of injured was not reported from the police or the hospitals. This number is probably small. The percentage police-reported accidents with human injuries is higher in Göteborg than in other parts of Sweden (62% as a mean value). The Swedish official statistics account for 45% of the number of seriously injured road casualties according to statistics from the Social Welfare Board. This number varies with the road user category: 60% for car drivers and passengers and approximately 45% for pedestrians and 20% for bicyclists (Nilsson, Thulin 1982). The slightly injured are reported to a far less extent. Thus, the economic benefit of the traffic safety investments in Göteborg is probably less favourable than indicated above. Nevertheless, traffic planning seems to be an important way to improve traffic safety. To prove that a more differentiated accident outcome classification is necessary.

The complete description of an injury includes its site, type, and severity. The site and type of injury can be defined rather well. The injury severity is not easily specified or defined. In official statistics "Serious injuries" form a large group including life-threatening injuries which may lead to permanent impairment. Some broken ribs and cerebral concussion may appear troublesome during a couple of weeks but sequels are rare. A cervical whiplash injury or a knee distortion seldom qualify for hospital care but cronical pain and impaired function during many years may be the result in several cases. When judging the severity of an injury by medical professions several factors are evaluated such as the extent of the injury, the threat-to-life, the period and extent of incapacity and the degree of permanent disability. Medical administrators are interested in the incapacity of the injured; whether he is able to ambulate or is forced to stay in bed, whether he is an out-patient or admitted to hospital wards. The insurance companies compensate for pain, suffering, and the percentage disability.

Injury severity can be classified using scales as The Abbreviated Injury Scale (AIS), The Injury Severity Scale (ISS), The Comprehensive Injury Scale (CIS), and the Probability of Death Scale (PODS). (Somers 1981). Further developed, these injury classification scales should be used in specialized studies on traffic accidents describing functional impairment and human response to injury and treatment (States 1981). This should be intimately correlated with the traffic accident analysis linking the cause and outcome of individual accidents. For cost-benefit analysis the accident outcome is more easily described as out- or in-patient and the number of days in hospital.

In this study car drivers and pedestrians were most frequently admitted to hospital; each in 27%. The average accident outcome differed significantly. About 70% of the car drivers could leave the hospital on the same day. Half of the other car drivers could leave the hospital the next day. Only 15% of all the car drivers had to stay in hospital for two days or more. More than 50% of the pedestrians were treated as in-patients. Half of them had to stay for one week or more in hospital.

From data collected by the National Social Welfare Board of Sweden Nilsson and Thulin reported on hospital in-patients injuried in traffic accidents in 17 of 24 counties in Sweden during 1977 (Nilsson, Thulin 1982). The number of casualties, the number of hospital periods, and the time in hospital were related to population and travel data. There was no connection to the accident data given in police reports. Their report illustrates how existing data can be used for general traffic accident studies. The data indicate the average accident outcome for urban and rural districts. The type of accidents differs in these areas. Another accident outcome is to be expected in urban traffic. The average time in hospital for various road user categories did not differ so much as in our study.

The time in hospital is the most significant accident outcome variable. The hospital costs, the time on sick-leave, and the corresponding payments from the health insurance office are complementary but less useful information. In this study half of the injured were not registrated at the health insurance office. In some cases the injured were registrated for illness not related to the accident. Thus, the number of days in the hospital and the number of visits to medical care as out-patients give the most practical and useful measure of the individual accident outcome for administrative purposes. The mean or the median values of these accident variables are proposed as parameters to compare the accident outcome for different categories of road users. The median values were used in this study. They are easy to determine and not influenced by random variation of any extreme observation.

The small number of accidents in this analysis does not permit subdivisions in age classes. Children and elders are important risk groups. They are usually unprotected and not adopted to the demands of modern traffic. Elders more often sustain life-threatening injuries and permanent impairment is more frequently seen as a result of traffic accidents in this age group compared to children. (Bunketorp, Romanus 1981). This analysis also indicates that pedestrians by far belong to the most expensive category of injured road users in Göteborg. According to Fig. 4 a considerable part of the budget for traffic regulation measures should be directed to improve pedestrian safety as far as human injuries are concerned. These investments should be concentrated to areas where elderly people stay.

Conclusions.

This study of traffic accidents in Göteborg 1971-1980 indicates:

- The usefulness of the NPK-TRAFO system for traffic accident analysis.
- A markedly decreased annual number of accidents as a result of road rebuildings and traffic regulations.
- A more favourable development of casualties than in the rest of Sweden.
- A slightly reduced number of fatalities, less favourable than in the rest of Sweden.
- A larger percentage of police-reported accidents than in the rest of Sweden.
- That pedestrians account for half the medical and social costs for injured road users.
- The importance of hospital-based injury classification to improve the cost benefit analysis for traffic safety investments.

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