The type, location and severity of injuries in car occupants in relation to accident situations and car damage.

By

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INTRODUCTION:

The aim of this study was to elucidate which role different collision situations played in the infliction of lesions upon persons involved in car accidents within a well-defined hospital district. From the same material we have tried to gather further knowledge about the relative importance of various preventive measures.

METHODS and MATERIALS:

The method used by the Odense University Hospital for registration of traffic accidents since February 1st 1971 is described in another paper in this congress report ( ). The hospital covers a mixed urban and rural district with 230.000 inhabitants suffering about 3000 traffic casualties per year. The area covers 1.150 km^2. There is one car per 2,8 inhabitants. This material will be referred to as the "total hospital material" (THM).

About 40% of these accidents are registered by the police, and in these cases the police description of the accident situation is transferred to the hospital registration chard. This material will be referred to as the "police and hospital material" (POHM).

In a period of 15 months (1.VI.1971 - 1.IX.1972) the material was supplemented by the local division of the National motorcar inspections' description of private cars involved in accidents, from which casualties were brought to the hospital. The combined car inspection and hospital material (CIHM) comprises 243 cars with 355 casualties and a total of 650 lesions.

The cars were picked out for inspection by the police. This selection might influence the CIHM in the direction of underrepresentation of cars hit from behind ("not guilty" cars). This reservation taken into account, the material can be used to a limited degree for certain observations.

The study is planned as a continuous survey of the traffic safety in the district concerned. As far as possible it is based upon coordination of routine registered information. Thus it does not allow us to go into technical details regarding car accidents. However, knowledge about the actual collision situations and the inflicted lesions is necessary

for utilization of laboratory experience in the actual traffic.

The situation description from the police follows the directives from the Danish Central Bureau of Statistics (6). The description from the car inspection was put on a special formula (figure 1) describing the direction and location of the main impact as well as the degree of external and internal damage to the car. The damage was estimated as none/slight/or severe.

RESULTS:

Type of lesions.

The total hospital material (THM) is computer operable for the period 1.II.1971 - 31.VIII 1972 (18 months). In this period it comprises 1370 occupants from private cars suffering a total of 2269 registered lesions, as indicated in figure 2. The lesion, which was expected to result in the most extended inability was chosen in each patient (1320 patients available for this analysis). This method of priority is the only one which can be clearly defined. Consequently all following comparisons of lesion severity will be based upon materials according to this principle. Parallel analysis have been made based upon the total number of lesions inflicted. These analysis showed results identical with those obtained from the materials arranged by priority, and consequently only the latter will be presented. Both analysis show a high incidence of head lesions followed by lesions of legs, arms and chest. There is a slight predominans of lesions of the limbs in the priority material in as much as these lesions most often result in extended inability.

The influence of location in the car.

This influence can be compared between 585 drivers and 301 front seat passengers from the THM (safety belt users excluded). There is an insignificant overrepresentation of lesions of the back and pelvic region in front seat passengers, and of chest lesions in drivers (p=o,o8), but no differens in severity of the lesions. The comparability of the groups regarding type of car, speed, etc. can not be judged. Back seat passengers have not been included in the analysis as they comprise many children.

The effect of safety belts.

The use of safety belts among the casualties is shown in table 1. The use of belts in cars in the normal traffic of the district concerned is roughly calculated to 15 - 21% based upon several traffic countings (road length and traffic intensity taken into account). Belt protection in actual collision situations may however be less common, in as much as the belt is used less often in town traffic, and this is just where most collisions occur. The dependence on drinking habits or other influential factors may also obscure the problem. Cases in which belt protection have prevented lesions

at all will not be represented, so that any effect found may be regarded as a minimum effect.

The anatomical distribution of the lesions according to use of safety belt is given in table 2. The table includes drivers as well as front seat passengers. There is a significant difference in distribution of lesions showing a lower incidence of head lesions and a relatively higher incidence of chest lesions in the belt using group ($p=0,0003$).

The severity of lesions in regard to use of belt appears from table 3. There is a significant reduction in the seriousness of lesions in the belt using group ($p=0,0006$).

The incidence of head lesions in the group where use of belt was unknown was even higher than in the non-using group. Therefore it is unlikely that this group should include an overrepresentation of actual belt users. Comparability of the materials with regard to car make, speed, etc. is not possible. The belt is known to be used 3-4 times more often in highway traffic than in urban traffic. It is therefore most probable that the belt group includes an overrepresentation of high speed accidents.

Influence of collision situation.

Figure 3 is based upon the police and hospital material (POHM). It shows the distribution of lesion severity in relation to different collision situations. The figure gives the relative relation between the various situations and the infliction of casualties upon car occupants. There is no significant difference in the severity of lesions in regard to the accident situation. A similar comparison was made between 305 car occupants hurt in crossing collisions and 115 hurt in collisions on road stretches. This comparison did not show any difference either. Finally the distribution of lesions in different anatomical regions were compared according to collision situations. This analysis neither shows any difference in casualties from varying situations.

The analysis throws light on the traffic hazards in the district concerned. Neither accidents without casualties nor persons involved, but not hurt, are included in the analysis. Therefore the relative danger for the participant in various accident situations can not be elucidated. This question can only be answered unanimously by analysing all collisions without regard to casualties. However such information is very difficult to obtain.

Influence of collision direction.

This influence can be judged from the CIH material.

The distribution of various collision directions and the severity of lesions inflicted upon the involved persons is depicted in figure 4. Head-on and front corner collisions covered 51% while 6% of the casualties were inflicted by left side impacts and 16% by right side impacts. 9% were aquired by turning over and 13% by multiple or unclassified impacts. 5% were inflicted by impacts in the rear or rear corners.

The excess of right side impacts compared with left side ones is significant (p=o,ool).

The influence of collision direction was compared between occupants in cars with frontal impacts versus cars with transverse impacts. Safety belt users as well as cars with none or slight external damage were eliminated in order to increase the comparability of the materials. The result of the analysis appears from table 4. The grade of the lesions is significantly more severe in the transverse impacts (p=o,o4).

The severity of the inflicted lesions were corellated with the degree of internal damage to the car. The lesions were significantly more severe when inflicted in cars with severe internal damage, compared with cars with none or slight internal damage (p=o,oo2). There was no difference in the anatomical distribution of the lesions. The analysis was restricted to cases with severe external damage to the car.

The influence of the distance from the occupant to the impact was investigated in transverse and oblique impacts inflicting lesions upon drivers and front seat passengers, in cars with severe external damage (disregarding use of belt). There was no significant difference in the severity of lesions inflicted in collisions with impacts in the three nearest sectors (near side impacts) compared with those which occured in the three farthest sectors (off side impacts).

An attempt was made to evaluate the effect of the safety belt in those situations, where maximum effect would be expected, i.e. head-on and front corner impacts with severe external damage to the car. However the number of belt users exposed to this situation only amounted to 24 cases, not allowing any statistical analysis.

Only 13 patients were hurt in cars with none or slight external damage, indicating that the CIH-material may represent the most severe part of the total hospital material. As mentioned before, the representation in the CIH-material is probable in view of the method of selection. However, the distribution of lesions with regard to anatomical region and degree of severity did not differ significantly from the THM to the CIHM although the latter contained a slightly higher proportion of severe lesions. This also holds true regarding the incidence of lesions in the neck, which was very low in both materials (THM 4,3%, CIHM 3,6%).

Discussion:

The importance of energy absorbing characteristics of the frontal and rear parts of cars, especially in connection with use of safety belts, has often been demonstrated in laboratory investigations, as has the importance of solidity of the passenger compartments. (1). However, the exact value of such protective measures in the actual traffic is difficult to assess. The value might be seen from the individual drivers point of view in the risk loaded situations to which he exposes himself. His problem is best answered from laboratory simulation of collision situations, combined with individual risk

estimation. However, to set an order of priority to collective protective measures the information needed by the communities must primarily be based upon knowledge of how casualties are inflicted in accidents in each community. For this purpose hospital statistics are absolutely necessary (2,10), but they must be combined with some source of information about accident circumstances. Our method of investigation allows a more broad spectered survey of the traffic security in the hospital district, than could be obtained from isolated sources of information.

Regarding car accidents we found it likely, that about 50% of all casualties inflicted upon car occupants are aquired in head-on collisions, and also significantly more often in right side impacts than in left side impacts. This distribution corresponds with the findings of Mackay (8) in an English material, in spite of the opposite direction of traffic in the investigated areas. We can not explain this phenomenon, but it might be ascribed to an inborn tendency to avert towards the left.

The effect of the safety belt has been well established (3,4,7). The total effect can not be described from a hospital material, which would demonstrate the minimum effect only. However in our experience even the hospital material shows a significant lower degree of lesions in belt users, as well as a significant redistribution of lesions away from head lesions, which with due justice are regarded as the most tragic ones. The high incidence of frontal impacts (51%) in conjunction with a 9% incidence of turn over, stresses the extreme importance of the safety belt in the prevention of lesions.

The importance of solidity of the passenger compartment is apparent from the significantly heavier lesions in connection with the internal damage to the car, disregarding the degree of external damage. This observation as well, - based upon a hospital material, - might be regarded as a minimum observable effect. However, our grading of external damage does not unanimously describe the degree of acceleration in the collision. Consequently, for the purpose of judging the effect of passenger compartment solidity, an evaluation based upon laboratory evidence combined with actual rate of occurence of transverse impacts, might serve better.

The distribution of lesions correspond with earlier investigations (2,4,5,6). Such descriptions are of conclusive interest only, when corellated with some causal factor or preventive measure.

Presuming that our material is representative, the analysis shows that lesions aquired in transverse impacts tend to be more severe than those aquired in frontal impacts. The distance from the occupant to the impact however, did not influence the severity of the lesions significantly. This is not in accordance with Bäckströms observations regarding fatal impacts (4). Our analysis of lesions inflicted in various accident situations, as described by the police, showed an almost identical pattern of lesions. Accordingly the situation

description does not seem to be essential when it comes to considering prevention of lesions. Accident prevention however should be based upon the situation description.

The occurence of impacts from behind was low as was the occurence of neck lesions. This phenomenon can be expected more often in close town traffic.

The results indicate that protective measures against lesions in car accidents should be given approximately this priority:

frontal 50%
transverse 20%
turn over & multiple 20%
rear 10%

SUMMARY:

The lesions inflicted upon 1370 occupants in private cars are analysed. There was no major influence upon lesions according to location in the car. Safety belt users aquired significantly less severe lesions than non-users. In 596 cases the accident situation was obtained from the police records. The lesions did not vary significantly what anatomioal location was concerned according to varying accident situations. Description of the damage on the car in which the lesions were inflicted was available for 355 casualties. This material showed an excess number of frontal impacts. Relatively more severe lesions were aquired in transverse impacts, although the type of lesions were the same. Right side impacts were significantly more common than left side impacts. The degree of internal damage to the car had significant influence upon lesion severity, while the distance from the occupant to the point of impact did not have major influence.

In cooperation with police assistent C. Thaarup and car inspectors M. Daldorph and K. Mosebo.

Computer analysis by P. Lagoni.

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Figure 1.

ODENSE SYGEHUS
SKADESTUEN

TRAFIKSKADEREGISTRERING.

Registreringsnummer: [illegible] Uheldsdato: [illegible] Journalnr.:

Beskadigelse:

	Ydre 0 +	Indre 3 +
Ingen 1		
Let 2		X
Svær 3	X	

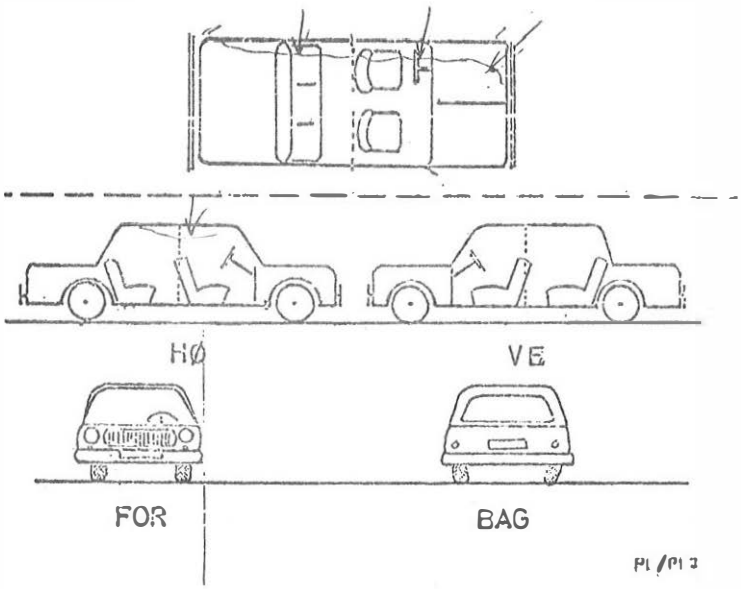

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Figure 2.

Distribution of the Lesions after Place in the Cars.
Total Material (without Priority of Injuries).
2269 Lesions on 1370 Patients.

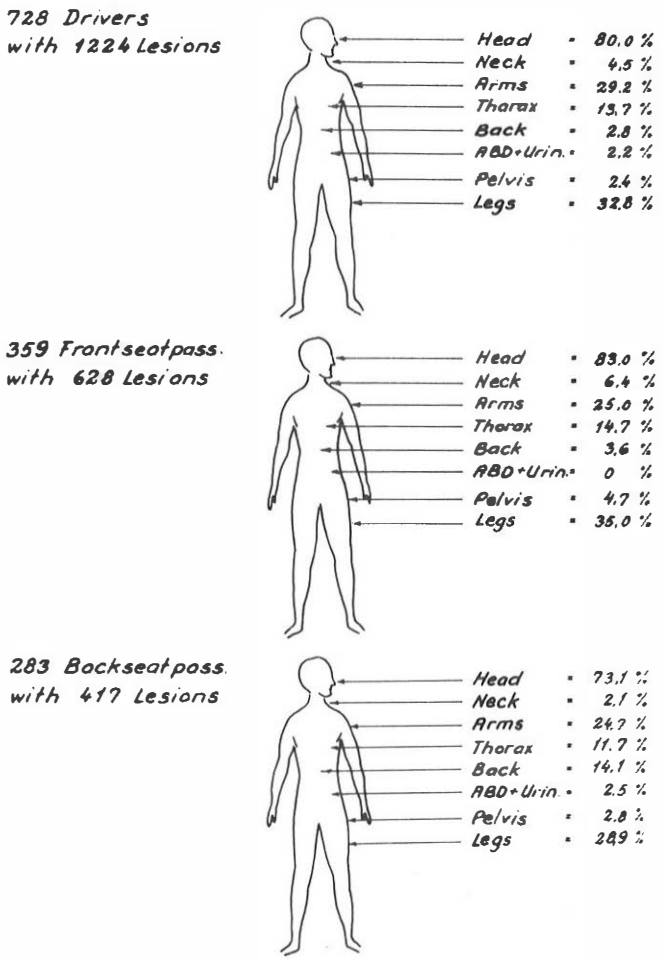

Figure 3.

The Severity of the Lesions in Relation to the traffical Situation just before an Impact.
Total Police reported Material. 656 Car Occupants.

		Suspected %	Slight No Inabil. %	Slight Inability <2 weeks %	Medium Inability 2-13 weeks %	Heavy Inability 3-6 Mth.s. %	Heavy Inability >6 Mth.s. %	Main Cause of Death %	Total %	Total Number of Casualities
1.	→ →	11.5	43.4	28.9	13.0	2.8	0	0	100	69
2.	→ ←	8.6	41.3	32.6	8.6	4.3	0	4.3	100	46
3.	→ ↷	7.4	51.8	22.2	14.8	0	3.7	0	100	27
4.	→ ↶	4.8	50.4	24.2	14.5	1.9	2.9	0.9	100	103
5.	↑ ←	6.2	42.0	24.1	22.0	2.7	1.3	1.3	100	145
6.	↶ ↑	10.0	40.0	30.0	16.6	0	3.3	0	100	30
7.	→ ▭	7.6	46.1	23.0	12.8	5.1	2.5	2.5	100	39
0	single	2.9	43.0	28.4	18.9	2.9	1.4	2.1	100	137

Figure 4.

The Severity of the Lesions compared with the Direction of the Collision (Car Inspection Material).

355 pts. = 193 Drivers
83 Frontseatpass.
79 Backseatpass.

in Addition 31 pts. *in Roll-over Accidents*
and 46 pts. *in multiple and unsolved Accidents.*

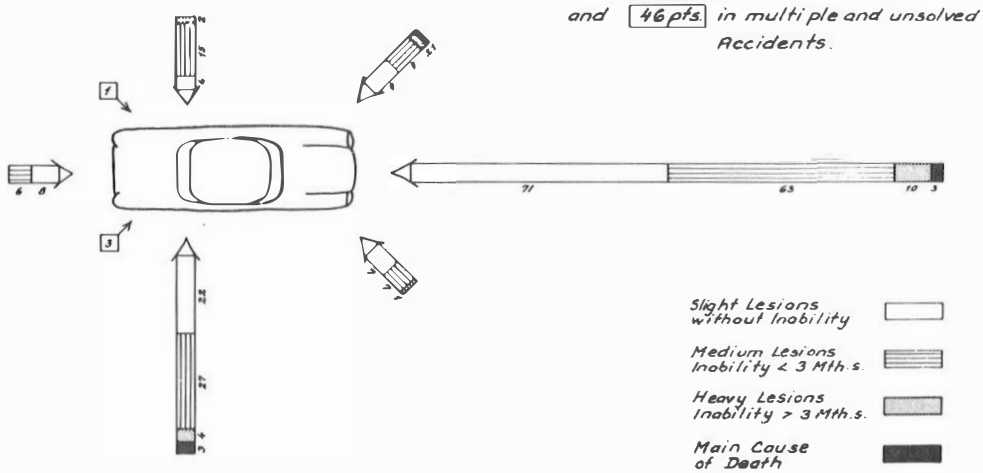

Table 1.

Use of safety belts (based upon 1087 injured front seat car occupants). (THM)

	drivers	front seat passengers
Belt used	60 (9,1%)	25 (7,3%)
Belt not used	600 (90,9%)	316 (92,7%)
Unknown	68 (9,3%)	18 (5,0%)
Total	728	359

The percentages are calculated from the total number in the unknown group, and from the number of elucidated cases in the other groups.

Table 2.

The regional distribution of the lesions upon front seat car occupants in relation to use of safety belts. (THM).

Region	+ Belt	÷ Belt
Head	30	493
Neck	2	27
Back	2	20
Thorax	21	64
Abdomen & urinary system	2	8
Pelvis	1	20
Arms	12	144
Legs	13	110
Total	83	886

Table 3.

The severity of lesions in front seat car occupants in relation to the use of safety belt. (THM).

	+ Belt	÷ Belt
Suspected	7	57
Light - no inability	45	413
Light - inability less than 2 weeks	19	233
Medium - inability 2 - 13 weeks	8	146
Heavy - inability 3 - 6 months	3	22
Heavy - inability more than 6 months	0	8
Main cause of death	1	7
Total	83	886

Table 4.

The severity of lesions inflicted upon occupants in cars with severe external damage (seat belt users excluded) according to direction of impact. (CIHM).

	Frontal impact	Transverse impact
None or slight lesions without inability	66	18
Slight lesions, inability less than 2 weeks	41	13
Medium lesions, inability 2 - 13 weeks	25	19
Heavy lesions, inability more than 3 months. Inclusive death	11	7