Status report of EEVC WG 21 Accident Studies

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ABSTRACT

Working Group 21, Accident Studies, has been formed to bring together analysis of existing accident data in support of the work programme of the EEVC. Its members represent all of the major in-depth accident databases in Europe and have access to a large number of others. This paper presents some of its early work.

A major task has been to conduct an audit of the available accident databases and to record their key characteristics. A total of 45 accident databases from 8 countries are identified and the paper lists factors including proprietary, data content, selection criteria, vehicles studied and purpose of investigation.

In general larger quantities of accident data are more likely to give statistically significant results and a second objective of the group has been to evaluate the feasibility and analysis potential of combining data from several countries. A pilot study was conducted to combine data from France, Germany and the UK to estimate the effectiveness of side airbag systems. A logistic regression model was developed which showed side thorax airbags reduced AIS 2+ thoracic injuries by 17%, although this was statistically not significant.

In support of WG 12, biomechanics, WG 21 has been asked to provide data on the types of leg injury sustained in crashes by occupants of three different age groups of cars in relation to future designs of ATD. A parallel analysis of UK and Swedish data is presented which shows the changes in lower extremity injury location and type.

Finally the paper will describe some of the current work of the group which is to assist the new work plan of WG 13, Side Impact Protection in relation to the further development of test procedures and side impact barrier characteristics.

BACKGROUND

The European Enhanced Vehicles Committee seeks to improve the safety performance of vehicles in use in the European Union. In order to do this new test protocols are developed that address critical issues of impact types or injury causation. It is important that these issues apply generally across the EU so that changes to car design, which are also made on an EU basis, make the greatest contribution to casualty reduction. To support the work it is important to have a good knowledge of accident and injury priorities across the EU and therefore to base the EEVC work on a broad picture of accident analysis. This is in line with the increasing demand at international and national levels to ensure that government and EU policies are based on sound evidence and established safety benefits.

EEVC WG 21 Accident Studies has been established to serve as a resource centre and information provider to the other WGs regarding the collection, analysis and review of accident data in the wider EEVC work programme. Its Terms of Reference are summarised as follows:-

1) To conduct an audit of existing and future accident data needs of the EEVC Working Groups and to identify areas where poor quality information diminishes the value of accident and injury data and its subsequent analysis.

2) To redress these deficiencies by obtaining better data and analysis from within or outside the EEVC countries, especially to make use of work of the EU-funded Pendant and SafetyNet projects.

3) Through the analysis of existing accident databases make recommendations to the EEVC Steering Committee where future EEVC coordinated research could be undertaken, that would lead to reductions in both the number and severity of accidents and injury.

4) Through the analysis of existing accident databases monitor developments in advanced safety systems, and attempt to determine their efficacy and deficiencies, in liaison with the other EEVC Working Groups, and report to the EEVC Steering Committee on a regular basis.

5) Develop regular links with each of the EEVC Working Groups.

METHOD OF WORKING

EEVC WG 21 provides an accident data analysis service to the EEVC, bringing together data from the eight countries represented. Each country has its own national level data that is available for analysis but several countries have routine in-depth crash investigations while others have special studies of selected crash types. One requirement of the Working Group has been to construct an audit of these databases and their essential characteristics, the complete audit is available on the WG 21 web pages and an extract is presented in this report.

WG 21 will utilise this data to address specific issues of other EEVC Working Groups. Once a clear specification of the data needs has been reached WG 21 will conduct a co-ordinated analysis of several datasets where equivalent tables are produced from each, an example is the analysis of leg injuries conducted for EEVG Working Group 12, Crash Dummies. Alternatively Working Group 21 has examined methods where datasets can be combined for certain types of analysis to increase the confidence in the results and an example is the study on side airbag effectiveness. Most recently WG 21 has commenced an extensive analysis of side impacts in order to support the work of WG 13, Side Impact and the work schedules of both Working Groups have been synchronised so that the results from WG 21 feed directly into the deliberations of WG 13. Examples of each of these analyses is given below.

AUDIT OF DATABASES

An early task of WG 21 has been to conduct an audit of databases available to the group to facilitate the selection of suitable data sources for subsequent analysis. A total of 46 separate data systems have been identified and their main characteristics have been listed. The names and summary details of the databases are shown in Appendix A and the fields recorded for each are shown in Appendix B. The full list with details is available on http://www.eevc.org. Some of these databases have been used for combined or parallel analyses within the group so far , some of the results are outlined below.

ANALYSIS OF LEG INJURY PATTERNS – WG 12 (DUMMIES)

In order to focus its work on new dummy characteristics WG 12 requested an analysis of the patterns of injury to the lower extremities showing any changes relating to the introduction of EuroNCAP and the EC Directive on frontal impact protection. The data from Sweden and the UK was used to address this issue and, since descriptive information only was required, a parallel analysis was conducted on each to a common specification. Although ideally the year of manufacture of the car would be a key parameter, describing the level of specification of the car, this is not available routinely on most of the crash injury databases so the data was categorised according to the year of registration of the vehicle. Each of these databases selects crashes that involve injury, but although there will be an injured casualty within the collision not all casualties are injured. The data cannot be used to assess the absolute changes on injury numbers but they do show any changes in frequency of injury of one body region compared to another. Table 1 shows the cases available from each dataset.

Table 1
Cases available for WG 12 leg injury analysis

Database	Year of Manufacture			Total
	1990-5	1996-9	2000+	
Swedish Strada data	449	258	410	1117
UK CCIS data	1060	1914	1288	4262
Total	1509	2172	1698	4379

A total of 4379 sets of occupant details were available for cars of the selected age ranges that were involved in frontal collisions. Figures 1 and 2 compare injuries to the lower extremity to other body regions for Swedish Strada and UK CCIS data. Since the lower extremity injuries that involve longer term impairment can have AIS values of 2 or higher the figures show the rates of such injuries to each body region.

Figure 1
Pattern of injuries – Strada

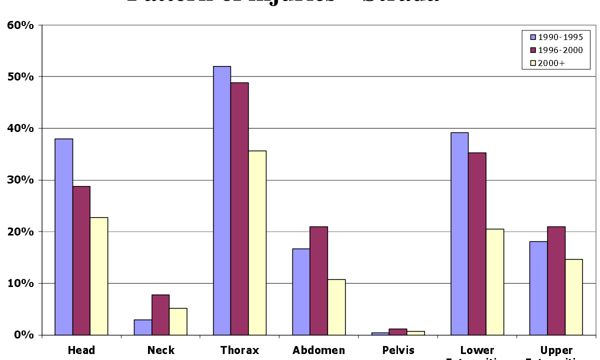
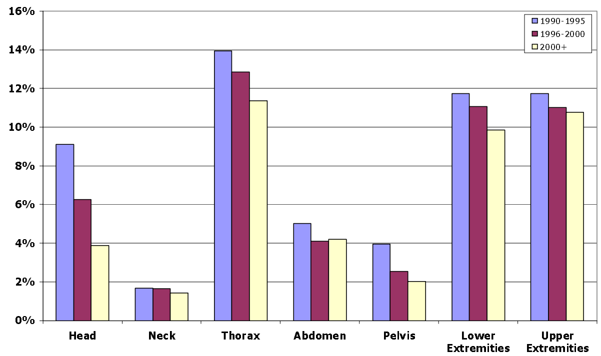


Figure 2.
Pattern of Injuries – CCIS



The case selection criteria for the three samples are different and the values cannot be directly compared, nevertheless consistent trends can be observed. All three datasets demonstrate a large reduction in rates of head and torso injuries. Injuries to the extremities were amongst the most common in all databases and mostly showed little or no decrease in relative frequency over the period studied.

The locations of injury are directly relevant to dummy design and determine the emphasis on specific locations for dummy instrumentation. The two datasets were also examined with respect to the injuries themselves, Table 2 shows the total AIS 2+ injuries from each group and Figures 3 and 4 show the locations of these injuries derived from each dataset.

Table 2
Injury details available for WG 12 leg injury analysis

Database	Year of Manufacture			Total
	1990-5	1996-9	2000+	
Swedish Strada data	141	70	71	282
UK CCIS data	283	413	413	1109
Total	424	483	484	1391

Figure 3.
Location of lower extremity injuries – Strada

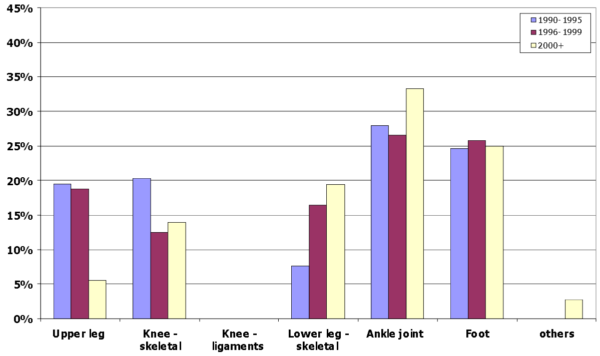
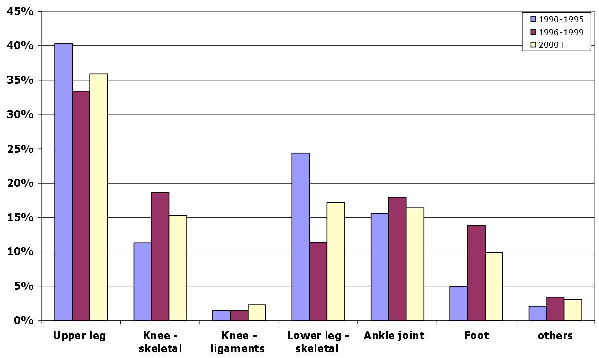


Figure 4.
Location of lower extremity injuries – CCIS



Although figures 3 and 4 show different distributions of injury location, possibly because of different vehicle fleets in the two countries both databases showed that ligament injuries to the knee were rare and also that the overall distribution of AIS 2+ injuries did not significantly change over the period 1990 – 2006. Otherwise the data from every country showed there remained a need for crash test dummies to measure the risks of injury at each part of the lower extremity.

PILOT STUDY ON ANALYSIS OF COMBINED DATASETS – SIDE AIRBAG EFFECTIVENESS.

WG 21 proposed to conduct a pilot study on the injury reduction effect of side airbags. It would also serve to evaluate the issues WG 21 would meet concerning parallel and combined data analyses from several sources in different countries. The group established that statistical modelling methods combined with case-by-case study would be the most suitable method.

During the last 5 years, the number of cars fitted with side airbags has dramatically increased. They are now standard equipment, even on many smaller cars or less luxurious vehicles. While some side airbags offer thoracic protection alone, there are those that combine thoracic and head protection (of which most deploy from the seat). Other systems employ separate airbags for head and thorax protection, which are designed to be effective noticeably in a crash against a pole. The Working Group 21 paper, presented at the ESAR Conference in September 2006[1], proposed an evaluation of the effectiveness of side airbags in preventing thoracic injuries to passenger car occupants involved in side crashes. Statistical analysis for head injuries was not possible due to the low number of accident cases with passenger cars fitted with head airbags in the databases.

First, the target population (who can take benefit of side airbag deployment and in what circumstances) was defined. Side airbags can be especially effective in cases of impacts on the door with intrusion at a certain impact speed. National data provides the overall magnitude of side impacts. For example, in France, side impacts account for about 25 % of fatalities (front and rear seats) and 18 % of seriously injured casualties in passenger cars. In the UK data 41% of fatally injured occupants died in side impacts and 37% of seriously injured casualties received their injuries in side impacts. 40 % of the French fatalities (respectively 60 % of those seriously injured) occur against another car, one third (respectively 30 %) against a fixed obstacle and 25 % (respectively 10 %) against a light or heavy truck.

70 % of the fatalities and 50 % of the seriously injured casualties in side impacts occur on the struck side with intrusion. Consequently, in France, 17 % of overall fatalities (70 % * 25 %) and 9 % of overall seriously injured casualties (50 % * 18 %) are the target population for side airbags, which are supposed to work for occupants seated against the struck door. This calculation was not done for either Germany or the UK.

Then, an example case of a side impact with side airbag deployment was given where side airbag deployment is thought to have had a positive effect on injury outcome. Actually, while statistical analysis and models can be used to derive a generalised view of accident data case by case reviews provide a complementary role. They are able to produce a fuller understanding of the real-world event and help to define key factors for use in subsequent modelling. An overall review of cases can help to define the most valuable selection criteria for cases to be included in the model and to avoid outliers. They can also provide a qualitative view of the limits of protection with side airbags. An additional expert case review can also indicate injuries that would probably have occurred without side airbags and identify potential airbag induced injuries.

The CCIS database was searched for examples of cases of medium to high severity side impacts with low severity occupant thoracic injury, cases were side airbag deployment may have been effective for injury prevention and a higher injury outcome may have been expected. Two examples of the cases found were presented in the paper.

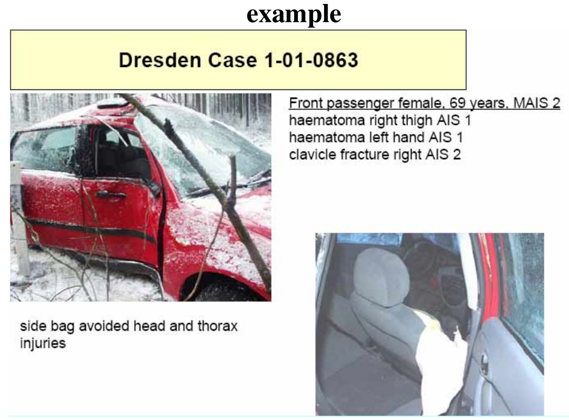
Then, the estimation of side airbag effectiveness (in terms of additional occupant protection brought exclusively by the airbag) was proposed by comparing injury risk sustained by occupants in (more or less) similar cars (fitted or non fitted with airbags). Comparing risks in similar cars was necessary since, during these years, car structure, and side airbag conception have considerably evolved.

In-depth accident data from France, the UK and Germany has been collected. Out of 2,035 side impact accident cases available in the databases, we selected 435 occupants of passenger cars (built from 1998 onwards) involved in an injury accident between year 1998 and year 2004 for EES (Energy Equivalent Speed) values between 20km/h and 50 km/h. The occupants belted or not, were sat on the struck side, whatever the obstacle and type of accidents (intersection, loss of control, etc.). For multiple impact crashes, the side impact was assumed to be the more severe one. Passengers cars were fitted with (96) or without (339) side airbags. Most of the potential risk explanatory variables were correctly and reliably reported in the databases (velocity – impact zone – impact angle – occupant characteristics, etc.).

The analysis compared injury risks for different levels of EES and different types of side airbags. A logistic regression model was also computed with injury variables (such as thoracic AIS 2+ or AIS 3+) as the dependant variable and other variables (including airbag type and EES) as explanatory injury risk factors. Results revealed statistically non-significant reductions in thoracic AIS 2+ and AIS 3+ injury risk in side airbag equipped cars in the impact violence range selected (odds ratio between 0.84 and 0.98 depending on types of airbags). The non-significance is assumed to be due to a low number of cases.

The GIDAS[23] [4]data was used to identify comparable in-depth cases with and without side airbags. These cases were used to illustrate the relative injury outcomes. An example is shown in Figure 6 below illustrating a case where the struck-side occupants sustained only minor injuries in the side collision. Overall the GIDAS analysis concluded side airbags gave a benefit in 41% of collisions and no benefit in 44% of collisions.

Figure 6.
GIDAS accident case example



SIDE IMPACTS

EEVC Working Group 13 has the objective to improve the safety performance of cars in side impacts. As part of a renewal of objectives and future work programme the EEVC Steering Committee has determined that analysis of crash injury data should form the basis of the work of WG 13. WG 21 has therefore been requested to conduct an extensive analysis of side impacts using a wide range of national level and in-depth datasets. This work is on-going but a sample of early results are presented below. These results are only available from analysis of the CCIS data at this stage and are therefore only indicative of any final conclusions, they may change as more data is examined. The analysis comprised an overview of the main characteristics of side impacts, comparing the frequency with that of other impact directions, followed by specific analysis of car to car impacts, pole impacts and non-struck side impacts. This paper presents only the interim results from part of the overview analysis.

Data in Table 3 shows the frequency of injuries according to the direction of impact. All casualties are occupants of cars registered after 1998, when the vast majority of new cars would have complied with the side impact regulation. Multiple impacts are excluded to ensure the injuries are associated with the main impact alone.

Table 3.
Severity of injuries by collision direction – CCIS data

	Injury Severity							
	MAIS 0		MAIS 1&2		MAIS 3+		Fatal	
Front	343	68%	1594	68%	240	59%	71	49%
Rear	17	3%	109	5%	5	1%	3	2%
Side	144	29%	651	28%	159	39%	74	51%
of which SS	*65*	13%	*358*	15%	*114*	28%	*54*	38%
NSS	*79*	16%	*293*	12%	*45*	11%	*20*	14%

At lower injury severity levels front collisions are the most frequent source of injuries, only 28% – 29% are sustained in side impacts. However the more severe injuries are increasingly associated with side collisions, 39% of MAIS 3+ casualties are in side collisions and these accounted for slightly over 50% of fatalities. The table also categorises side impact casualties according to whether they are seated on the struck side or the far side. At each severity level the majority of side impacted occupants were seated on the struck side, 28% of fatally injured side impacted occupants were seated away from the impact on the non-struck side. Table 4 shows the nature of the collision partner according to the severity of injuries sustained by each occupant of a side impacted car.

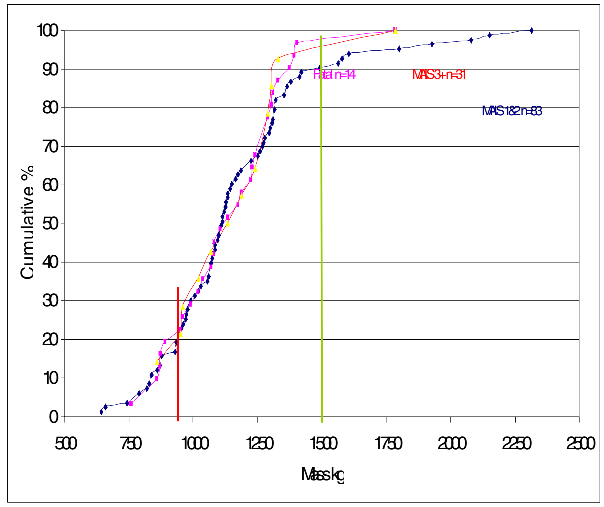
Table 4.
Collision partner – struck-side casualties

	MAIS 3+	Fatal
Single Vehicle	43%	48%
Car/Car derivative	33%	30%
TWMV	2%	0%
MPV/LGV	7%	6%
HGV/Bus	12%	17%
3+ Vehicles	3%	0%
Total	100%	100%

The UK CCIS data indicates that nearly half of all struck-side fatalities are in single vehicle collisions while only 30% are in collision with another car. 17% are involved in impacts with large goods vehicles or buses. Of the single vehicle collisions only 27% struck a narrow road-side object, less than 41cm wide, broadly corresponding to a lamp-post or sign-post.

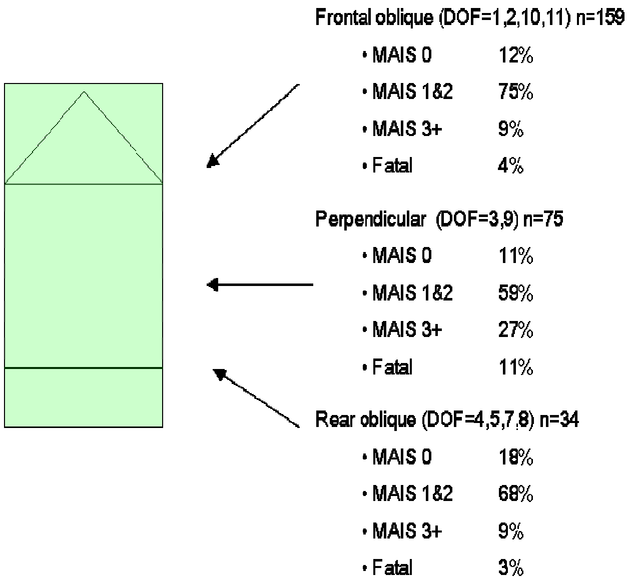
Figure 7 shows the mass of the collision partner when it was a car. Nearly 80% of all striking cars had a mass exceeding 950 kg, the mass of the deformable barrier however less than 10% were above 1500kg. The figure also shows how the distribution of mass varies according to the severity of the injuries of the struck-side casualties. In the absence of more detailed analysis there does not appear to be any link between mass of the striking car and injury outcome although these results have not yet been adjusted for collision severity.

Figure 7.
Mass of striking car.



The standard test condition for side impacts in the EC directive and the EuroNCAP test involves a perpendicular impact to the vehicle, however the need for a different condition is still debated. Figure 8 shows the distribution of injury severity for the oblique and perpendicular impacts of struck side occupants.

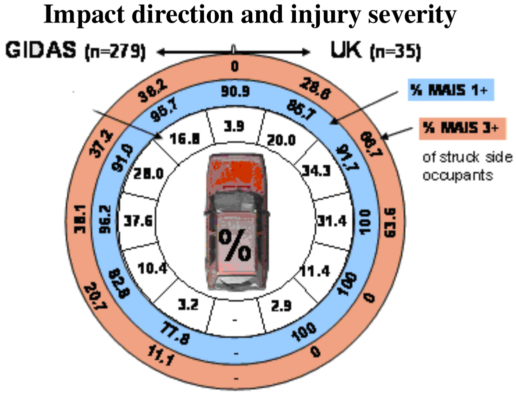
Figure 8.
Perpendicular and oblique side impacts



Analysis of the data shown in Figure 8 indicates that although oblique impacts to the front or rear were more common than perpendicular impacts they were less likely to involve severe injury. 70% of the total impacts in Figure 8 were oblique but the numbers of fatalities in each configuration were equal. The risk of fatality in perpendicular collisions was 10% compared with only 4% in oblique impacts. Similarly the rate of MAIS 3+ injury in perpendicular collisions was 25% compared with 9% in oblique.

The same distribution was obtained for impacts with poles and the data for Germany and the UK is shown in Figure 9 below. This diagram illustrates that perpendicular collisions are the most likely to result in injury.

Figure 9.
Impact direction and injury severity



Conclusion

The work of EEVC Working Group 21 focuses on a wide range of subjects, of which a sample have been presented in this paper. The group is able to conduct detailed analysis of many datasets to a common end. These analyses can cover several datasets using a set of common specifications or be based on a combined dataset where certain outcome parameters can be modelled.

Over 45 different datasets of a variety of levels of detail can be accessed by the group including national and in-depth data. This data is gathered using a wide variety of case selection procedures, while this mixture may limit detailed comparability it also may mean that a much wider range of analysis questions can be addressed.

Acknowledgement

This paper uses accident data from the United Kingdom Co-operative Crash Injury Study. CCIS is managed by TRL Ltd on behalf of the Department for Transport (Transport Technology and Standards Division) who fund the project with Autoliv, Ford Motor Company, Nissan Motor Europe and Toyota Motor Europe. The data were collected by teams from the Birmingham Automotive Safety Centre of the University of Birmingham, the Vehicle Safety Research Centre at Loughborough University, and the Vehicle & Operator Services Agency of the Department for Transport. Further information on CCIS can be found at http://www.ukccis.org.

This paper contains data and analysis from the German In Depth Accident Study (GIDAS). GIDAS is a joint project between FAT (Forschungsvereinigung Automobiltechnik or Automotive Industry Research Association) and BASt (Bundesanstalt für Straßenwesen or the Federal Road Research Institute).

Appendix 1: list of available accident databases

Database name	Full Name	Owner
EACS	European Accident Causation Survey	ACEA + ACEA Members
PVM-90	Fatal Accident Analysis 1990	LAB
PVM-2000	Fatal Accident Analysis 2002	LAB
ETAC	European Truck Accident Causation	IRU + EU
EDA	LAB In-Depth Car Accident Investigation	LAB
LAB	LAB - in house	LAB
CHILD	Advanced methods for improved Child Safety	European project consortium
RISER	Roadside Infrastructure for Safer European Roads	EU
TRUCK	In-Depth Truck Accident Analysis	RENAULT TRUCKS
BUS	In-Depth Bus Accident Analysis	IRISBUS
EDA	INRETS In-Depth Car Accident Analysis	INRETS
MAIDS	Motorcycle Accident In-Depth Study	ACEM
RIDER	In-Depth Motorcycle accident research	French Government (Department of Research), CEESAR
OTS	On The Spot accident research project	UK Department for Transport
GIDAS	German In-Depth Accident Study	GIDAS consortium (BASt and several manufacturers/suppliers)
PENDANT	Pan European co-ordinated Accident and Injury Databases	EU
CARE	Community Road Accident Database	EU
CCIS	Co-operative Crash Injury Study	UK Department for Transport with industry co-sponsors (see Acknowledgement)
SAFETYNET	European Road Safety Observatory	EU
TRAMS	Tram Accidents	Dutch Transport Safety Board
SUV	Sport Utility Vehicles	TNO
TRUCKS	Truck Accidents	SCANIA
UK Travel Survey	UK Travel Survey	
STAT 19 enhanced	STATS 19	UK Department for Transport
SSIS	Sistema Integrato Sicurezza Stradale	Milan province, Sorrento city and Salerno city
BAAC	French Injured Accident Analysis Report	French Government (Department of transport)
OGPAS	Official German Police Accident Statistics	Federal Statistical Offices of the German States
GMS2002	German Mileage Survey 2002	BASt
VW- In house	VW - In house	VW
GNS	Greek National Statistics	National Statistical Service of Greece
DGT database	Spanish General Directorate of Traffic - Road Accidents Database	Spain Government (Department of Transport)
DIANA	Proyecto de Investigación y Análisis de Accidentes	CIDAUT
LMU - FARS	Getötetendatenbank. Accidents with fatal injuries in Bavaria	LMU
KISS	Kraft Informations Statistik System der Allianz	Allianz Insurance

Database name	Full Name	Owner
ROLLOVER	Improvement of Rollover Safety for Passenger Vehicles	European project consortium
AJBCN	Ajuntament de Barcelona (Barcelone Council)	Barcelone Council
BUS - SP	In-depth accident investigation with buses involved in Spain	DGT-Applus + IDIADA
PED - BCN	Pedestrian Barcelone	Barcelona Council - Applus + IDIADA
SINGULAR CASES	Singular cases - Isolated incidents	Applus + IDIADA
SCT	Servei Català del Trànsit	Catalonia Government
BIA	Barcelona Investigació d'Accidents (Accident Investigation Barcelone)	Càtedra Applus
TROHOGNOMON	Trohognomon (traffic accidents investigator company) database	Trohognomon company
IRTAD	International Road Traffic and Accident Database	EU
DEKRA	DEKRA Accident Database	DEKRA
In-depth studies of fatal accidents	In-depth studies of fatal accidents	Swedish Road Administration
STRADA	Swedish TRaffic Accident Data Acquisition	Swedish Road Administration
SEWIK	Polish State Police Accident Database	Polish State Police
ITS Accident database	Institute for Transport Studies database	Institute for Transport Studies, Poland

Appendix 2: Main characteristics recorded for each database.

Database name	
Full Name	
Owner	
Investigation Teams	
Principle focus (active, passive, both etc)	
Main Objective	
Type of investigation	In-Depth Acc. On the spot
	In-Depth Acc. Delayed Time
	Police Report Anal.
	Exposure Data
	Stat. Data
Vehicle types covered	Car
	Two Wheelers
	Ped.
	Truck
	Bus
Years of accidents	
Selection criteria	
Sampling details	
Most suitable applications	
Status	
Nb Acc/year (average)	
Total no of vehicles on database (up to now) or expected	
No of vehicles year model >= 2000	
Use of Data	Any special condition
	Raw data available
	Own Team processes
Comments on application for passive or active safety research on modern vehicles?	
Any other information	
Software	
Available export format	
Language	
Region covered	Region
	Comment
Documentation	Methodology
	Coding Convention
	Statistical Sampling plan
	Questionnaire
	Glossary of terms
Data Content	Pictures available
	Cause of accidents
	Cause of injuries
	Human Factors
	Vehicle technology
	Accident situation

	Road user
	Reconstruction

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