DEVELOPMENT OF THE ACCIDENT INVESTIGATION AND DATA HANDLING METHODOLOGY IN THE GIDAS PROJECT

Andre Seeck
Jost Gail
Ferderal Highway Research Institute
Germany
Raimondo Sferco
Ford Motor Company
Germany
Dietmar Otte
Medical University Hanover
Germany
Lars Hannawald
VUFO GmbH
Germany
Hans Zwipp
Medical University Dresden
Germany
Jörg Bakker
Daimler AG
Germany
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ABSTRACT

Since its beginning in 1999, the German In-Depth Accident Study (GIDAS) evolved into the presumably leading representative road traffic accident investigation in Europe, based on the work started in Hanover in 1973. The detailed and comprehensive description of traffic accidents forms an essential basis for vehicle safety research. Due to the ongoing extension of demands of researchers, there is a continuous progress in the techniques and systematic of accident investigation within GIDAS. This paper presents some of the most important developments over the last years.
Primary vehicle safety systems are expected to have a significant and increasing influence on reducing accidents. GIDAS therefore began to include and collect active safety parameters as new variables from the year 2005 on. This will facilitate to assess the impact of present and future active safety measures. A new system to analyse causation factors of traffic accidents, called ACASS, was implemented in GIDAS in the year 2008.

The whole process of data handling was optimised. Since 2005 the on-scene data acquisition is completely conducted with mobile tablet PCs. Comprehensive plausibility checks assure a high data quality. Multi-language codebooks are automatically generated from the database structure itself and interfaces ensure the connection to various database management systems. Members of the consortium can download database and codebook, and synchronize half a terabyte of photographic documentation through a secured online access.

With the introduction of the AIS 2005 in the year 2006, some medical categorizations have been revised. To ensure the correct assignment of AIS codes to specific injuries an application based on a diagnostic dictionary was developed. Furthermore a coding tool for the AO classification was introduced.

All these enhancements enable GIDAS to be up to date for future research questions.

INTRODUCTION

Though having the advantage of leveraging the whole experience in accident collection methodology of the Hanover medical university, a large project like GIDAS with its staff of about 100 people has a lot of aspects to care about [1,8], while being confronted with new challenges. Additionally, changing demands from customers and improvements in technology lead to a continuous evolvement of the project. This paper tries to highlight some of these changes and improvements in the methodology of the GIDAS accident collection effort.

PRIMARY VEHICLE SAFETY

In the last years vehicles are fitted more and more with primary vehicle safety systems like e. g. anti-lock braking systems (ABS), traction control, vehicle stability control (VSC) or other advanced driver assistance systems. Since these active safety systems are expected to have a significant and increasing influence on reducing accidents, fatalities and injuries in the future, this should show up in accident databases as well. In-depth studies therefore began to include active safety issues as new variables and to collect corresponding data. In the German In-Depth Accident Study (GIDAS) such a data collection was started with the year 2005 [2]. Features like e. g. adaptive cruise control, lane departure warning systems, park distance control or night vision systems are included now. On the one hand it is recorded whether the vehicle is fitted with some of these devices, on the other hand it is recorded how sophisticated the system is or which kind of functionality the system offers. It is the aim to be able to assess the positive or negative impact on traffic safety associated with these devices after several years of data collection.

Since active safety systems are developed to avoid accidents it seems to be an antagonism to detect effects in in-depth accident studies. Accidents which are avoided by these systems will not take place and thus will not appear in the database. However, it might be possible to elaborate cases in which a certain vehicle segment is equipped with a safety device and a second comparable segment is not. Such a situation would allow checking whether the segment of vehicles not being equipped is to a higher extent involved in special classes of accidents than the vehicles being equipped.

Prerequisites

An assessment of the impact of active safety measures by means of accident analyses should help to optimise the systems and give advice for policy making with regard to vehicle safety. For such an impact assessment it is necessary that accident data can offer information about the following items:

- Was the vehicle equipped with the safety system of interest?
- If yes, was the system enabled?
- If yes, did the system influence the course of the accident?
- Could a system which was not fitted to the vehicle have had an accident avoiding or mitigating effect if it had been fitted?

The possibility to benefit from collecting active safety data while analysing accidents at the roadside depends on the usability of the data recorded. A general and obvious prerequisite is that the physical figures and facts are ascertained correctly and the questions to the participants are answered truly.

To determine the safety gains of a system the user of the accident database needs as much cases and as detailed figures as possible. A sufficient number of cases will be reached earlier if more vehicles are equipped with the relevant systems. For the majority of active safety devices this will require to wait for several years.

Another prerequisite is that the real accident causes are known. Only with this knowledge it can be assessed whether the active safety system has had a chance to interfere and do its beneficial job. Here accident reconstruction as a part of in-depth study is indispensable especially for active safety issues.

Attributes of Active Safety within GIDAS

In a special record GIDAS collects the information by means of about 80 variables associated with primary safety. Among others driving stability, braking performance, tyres, visibility, lighting or ergonomics are addressed.

Some examples of issues of active safety systems being recorded in GIDAS are:

- Cruise Control / Adaptive Cruise Control
- Lane Departure Warning / Lane Change Assist
- Mirrors
- Daytime Running Light
- Advanced Frontlighting Systems
- Night Vision
- Parking Aid
- Run-Flat Tyres
- Collision Warning / Collision Mitigation
- Brake Assist

Also the function and operation of communication systems and comfort systems which enhance or at least influence the condition of the driver are part of the active safety record. It is for example checked how the phone or the navigation system can be operated, whether a voice control is there, how the gear shift can be operated or where the buttons and switches for the engine brake or the distance control system are located etc..

Some of the active safety systems can be found together with the primary information of the vehicle in another record of the GIDAS database. This is the case for technical failures, vehicle stability control systems or anti lock braking systems. Information about active safety features is also available via the recorded questioning of the drivers or other participants of the accident. There it is asked what the reaction of the driver was with regard to steering or braking, how the visibility conditions were and what was done or operated before and during the course of the accident and why. The questioning comprises also whether the driver has knowledge about certain safety features like ABS or brake assist which his vehicle is fitted with. The driver also should state if he had got some feedback from operating safety systems.

The GIDAS Codebook [3] yields a detailed listing of all active safety variables being recorded.

For each of the active safety variables a certain value is recorded in GIDAS, indicating whether the vehicle was equipped and - if yes - representing system properties. As an example, the variable "run flat tyres" is split up into the following values:

0) not applicable
1) yes (without add. info)
2) no
3) with support ring
4) reinforced side wall
5) repair kit
8) others
9) unknown

Together with the launch of collecting primary vehicle safety data an expert group was established to accompany this part of the data survey. The group is responsible for the selection of variables and their parameter values. In addition, refinements, updates and checks of the variables associated with active safety as well as discussion on the usability of the data collected are carried out by the group.

Accident Reconstruction Analysis

Based on data collection at the accident scene with documentation of all tyre marks and artefacts at the scene, the final position of vehicles and vehicle deformation pattern, the motion of casualties during the collision phase can be reconstructed after the accident and the speed of vehicles can be determined. A true to scale drawing based on 3-D-Laser-Scans and fotogrammetric procedure are the basis for the technical-physical analysis as well as for the replication of the vehicle motion and other important parameter for describing the accident severity, i.e. delta-v and EES. For pedestrian accidents the absolute collision speed is calculated on traces and throw distances [9].

Accident Causation Analysis

As the official German catalogue of accident causes has difficulty in matching the increasing demands for detailed psychologically relevant accident causation information, a new system, based on a "7 Steps" model, so called ACASS, for analyzing and collecting causation factors of traffic accidents, was implemented in GIDAS in the year 2008. A hierarchical system was developed, which describes the human causation factors in a chronological sequence (from the perception to concrete action errors), considering the logical sequence of basic human functions when reacting to a request for reaction. With the help of this system the human errors of accident participants can be adequately described, as the causes of each range of basic human functions may be divided into their characteristics (influence criteria) and further into specific indicators of these characteristics (e.g. *distraction from inside the vehicle* as a characteristic of an *observation-error* and *the operation of devices* as an indication for *distraction from inside the vehicle).* The analysis of the human causation factors in such a structured way provides a tool, especially for on-scene accident investigations, to conduct the interview of accident participants effectively and in a structured way.

Perspective of Recording Active Safety Data

The effort of collecting active safety data within in-depth accident studies is based on expectations that the data will be suitable to show the impact of any safety, comfort or communication device on traffic safety, either positive or negative. Knowing this impact will enable researchers or policy makers to carry out cost-benefit assessments for the introduction of safety measures and to take corresponding actions. The latter was done in the past mainly for passive safety devices like seatbelts or airbags. Now the analyses should be extended to measures concerning longitudinal and lateral control of vehicle dynamics, vision, conspicuity or ergonomics. First studies were carried out with regard to vehicle stability control, brake assisting systems and automatic emergency braking [4-7]. Knowledge about the real safety benefits will on the one hand help to optimise the systems and on the other hand to support legislation.

Researchers in the area of vehicle safety therefore hope to be able to answer questions like e. g.

- how far do advanced (emergency) braking systems reduce (severity of) rear end accidents?
- what is the influence of lane keeping or lane change assist on accidents with vehicles in the adjacent lane?
- does a head-up display reduce accidents due to eye distraction?

The importance of gaining information about active safety will increase in the next years since progress in vehicle safety will rely more on accident avoiding systems rather than on classical passive safety measures.

Although the number of recordings for active safety is still small and biasing effects do not always allow carrying out statistical evaluations the examination of single cases already helps to get insight into the accident avoiding mechanisms and the possible benefits of active safety devices. Especially for vehicle or system manufactures information gathered from these single cases can therefore be useful already at the time being.

But if the demonstration of safety benefits will be possible for a safety system only fitted to a minority of vehicles now, this would indicate a big potential for traffic safety since a coming high market penetration would lead to a high safety gain in the future. Under the assumption that the equipment rates grow linearly the effects in accidents and accident databases should increase nearly to the square since the vehicles being equipped once will remain in the stock for years.

There is no doubt that starting to collect active safety data was a necessary and sensible step, but patience is needed for searching for effects in in-depth accident databases.

DATABASE STRUCTURE

Several important steps have been undertaken to further optimise the process of data handling with GIDAS. In all areas of work, from data input to data utilisation by the end-user enormous improvements were achieved.

Relational Database Structure

During the last years the GIDAS database has been converted into a completely hierarchically structured relational database. In accordance with the common definition enacted by the expert group, the database has been organized in different records, that are recombined for each single accident, providing the user a logical comprehension and overview. Thus, the structure contains only the exact data records the accident requires and allows a consistent comparability of accidents on every level of the dataset. Furthermore, GIDAS now allows a common interface to export the data to various database management systems. Due to this fundamental advancement a database independent data access is now guaranteed. However, despite of these radical amendments it was carefully ensured that all previous cases were included and updated, always allowing an analysis in accordance with the corresponding dataset version.

Multilingual Codebooks

To guarantee an easy and consistent analysis of each dataset copy, the codebooks are automatically generated in concordance with the current database version. The codebook itself is stored in a database, ensuring a perfect compatibility with each dataset copy. In addition to that the data input-forms are derived from this database likewise, to allow an up-to-date encoding of each case by the teams.
Furthermore, to meet the expectations of various different clients, a new codebook structure has been developed. As more and more international contractees and associates work with GIDAS, the necessity of a multilingual access to the data led to the realization of a codebook database comprising more than one language. Currently a German and an English version are available and further languages can now easily be added.

Quality Management

Due to the enormous amount of recorded data, errors can hardly be excluded. To reduce mistakes and implausibilities in the database, a thorough reviewing network has been developed. To keep track of necessary amendments and corrected errors a joint platform has been created. After processing each error, possible automatic plausibility checks are applied to exclude the error in future cases. These plausibility checks do already take effect during the coding process to reveal errors right away. In addition to that a verification of completeness follows every encoding section to prevent an inadvertent loss of information. Finally, every case that is completely coded goes through a peer-reviewed double-check and will be returned for discussion if an obvious error is found. In this process, repeated time consumption by mistakes is reduced to a minimum and a steady improvement of data quality can be achieved.

External Sources

During the constant review of specific variables in the expert groups several sections were brought out that asked for additional sources. As there are sometimes inevitable circumstances (both logistic and physical) that impede a thorough data acquisition at the accident scene, external databases and resources are now used to provide additional information and fill this gap. Thus, vehicle databases, environment information and official police records are acquired after the accidents, to deliver crucial specifications.

On-Spot Digital Data Recording

Another fundamental improvement was the introduction of mobile tablet computers for the on-spot data recording. Not only was the time for data encoding reduced significantly because transferring the data from the forms to the database could be avoided, also was the loss of information during this process eliminated. Using the "database to go" the team sees necessary variables right away and encoding aids apply immediately, again saving time and preventing errors. Also the electronic forms were adapted exclusively for the on-spot encoding to meet the special circumstances at the scene. Furthermore, the recorded data is available for processing immediately, allowing up-to-date discussions and fastest results for data analysis.

Online Data Access

Finally, the complete data access for the contractees and associates has been renewed and modernized essentially. In a new web area a secured online access is now available to obtain both data and photographic records. Unique and user-specific access authorization grants secure access to all online data. A tool for efficient synchronization of half a terabyte of photographs and related files has been implemented and guarantees the members of the consortium fast and up-to-date access to all data of each accident case. An up- and download area and a content management system allow a modern interaction and exchange of experience of associates in different projects or working groups. Finally a webgallery of all accident files even provides quick access to the data on the move.

MEDICAL ASPECTS

To provide the best possible utilisation of the obtained data and derive both strategies and ideas for innovations, a complete understanding of the whole accident situation is indispensable. Beside the documentation of the course of the accident, the technical equipment, and environmental factors, detailed information about the medical aspects of the accident are given in GIDAS. Apart from the specific physiological and psychological specification of the involved persons, a thorough documentation of all injuries is ensured, including the injury causation, the rescue phase, treatment and therapy, rehabilitation, and outcome. To accomplish this goal the data acquisition is performed by specially educated medical personnel right at the accident scene, in cooperation with the rescue services during transport, and physicians at the clinics. Subsequently, comprehensive interviews are conducted and all medical results are analysed. The following illustration gives an overview of the medical data input (See Figure 1).

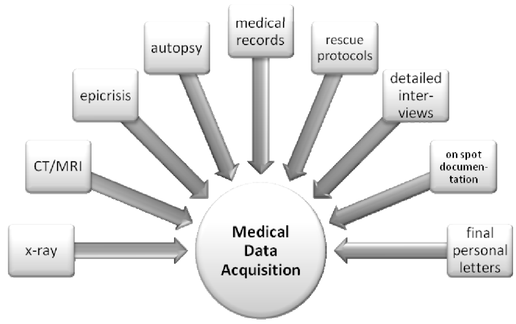

Figure 1. Overview of medical data input in the GIDAS accident investigation process.

New Technological Possibilities

To provide a steady high-quality data acquisition, several new technological possibilities have been incorporated in the medical investigation during the last years. The use of high-quality digital photography at the accident scene and for the documentation of x-rays and medical results allows a higher level of detail for the injury description. To preserve these specifications new software for diagnostics and classifications were implemented consequently. With this higher level of injury specification a more comprehensive understanding of the causation and coherences is given to allow data analysis in various new sectors. The use of clinical software for the analysis of computer tomography scans and magnetic resonance imaging now even permits the detection of concealed injuries for an extensive coverage.

Systematic Injury Encoding

As the Association for the Advancement of Automotive Medicine published a new Abbreviated Injury Scale (AIS) in 2005 a broad step towards a more systematic injury encoding has been undertaken in GIDAS. After the AIS code has been coded for suffered injuries ever since, the catalogue is now the principal basis for the injury specification. Including the assignment of a specific identification number for each injury, numerous specifications can now be encoded automatically excluding typing errors or mistakes with regard to contents. Providing a diagnostic list of all possible injuries described by one single ID, GIDAS offers essential and consistent filter possibilities for data analysis. Furthermore the inclusion of both old and new AIS codes allows a continuous and comparable investigation of existent and future cases to exclude bias from the scale change and distinguish real trends in accident severity.

In-Service Education

Since only innovative and state of the art knowledge allows prospective inventions, the continuous education and advanced training of the medical team members has become a primary commitment during the last years. An important part of this development was the clarification of a standardized scheme to interview the involved persons and the instruction of the team by professional psychologists. Thus, the recorded data becomes not only more comparable and consistent but also more exhaustive as the compliance of the involved persons could be increased notably. In addition to that qualified lecturers from business associates and educational institutions inform the teams about technological automotive improvements and essential fields of attention in periodic trainings and review courses.

CONCLUSIONS

Over the years, the GIDAS project has seen several improvements in various fields of the accident data acquisitioning process. This includes:

- Inclusion of primary safety systems.
- Analysis of accident causation.
- Improved data management and distribution.
- Maintenance and generation of multilingual documentation closely tied to the database structure.
- On spot digital recording and leveraging of a variety of technical third-party data sources.
- Introduction of AIS 2005 and a corresponding diagnostic dictionary.
- Program for classification of fractures.

Despite the high level that already has been successfully achieved, the challenge remains to adapt to changing and increasing demands in the need of comprehensive accident data. So, the concerted effort of all contributors to the GIDAS project can be viewed as a work in progress.

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