Widespread Collection of Real-World Crash Data Using Advanced Automatic Collision Notification and Medical Data Technologies

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ABSTRACT

Standard methods of investigating real-world crashes are hampered by the rapid rate at which the vehicle fleet changes as well as logistical hurdles involved in collecting sufficient quantities of data regarding specific vehicle and crash conditions to draw useful conclusions regarding injury causation. This degrades the ability of real-world crash data to contribute in a timely fashion to the assessment and improvement of vehicle and occupant protection systems.

The University of Michigan Health System, General Motors and OnStar are collaborating on a project to collect real-world crash data using the OnStar system to identify and screen crash cases from around the US. For crash events of interest, informed consent is obtained, medical interviews are conducted and the vehicle is inspected for photographic documentation. Medical records and digital medical imaging data files are also obtained for determination of injury mechanism and outcome.

Most real-world crash data collection systems have limitations. Systems in which a small subset of crashes is randomly sampled have very limited numbers of crashes from specific vehicle models and crash conditions. Geographically based census collection systems can have the same limitation. Medically based crash data collection systems provide optimal detail and insight regarding injury causation factors, but are also biased by being outcome-sampled and expensive. The novel use of advanced automatic collision notification technology for screening allows researchers to very efficiently identify the subset of real-world crash cases that hold most value for assessment of injury risk or evaluation of vehicle safety performance. Cost effectiveness will increase even further once photographic documentation of crash damage is no longer necessary. The involvement of independent, academically based medical researchers significantly enhances subject enrollment and enables the collection of sensitive medical records and digital imaging data.

INTRODUCTION

Deaths and injuries resulting from motor vehicle crashes are the leading cause of death for people of every age from 3 through 6 and 8 through 34 (based on 2005 data). During the year 2007 in the United States, 41,059 people were killed in the estimated 6,024,000 police-reported motor vehicle traffic crashes and 2,491,000 people were injured (1).

Efforts to improve traffic safety must be guided by real-life data that is timely, accurate, precise and representative. There are many research projects and databases that collect and analyze traffic safety data, each with their distinct advantages and disadvantages.

The National Automotive Sampling System (NASS) Crashworthiness Data System (CDS) is a nationwide crash data collection program sponsored by the U.S. Department of Transportation. It is operated by the National Center for Statistics and Analysis (NCSA) of the National Highway Traffic Safety Administration (NHTSA). NASS/CDS data has very significant strengths including its reliable sampling weights and its nationally representative data. Approximately 5000 crashes are collected each year with detailed analysis of the vehicle. Vehicle occupant interviews as well as police records are utilized to gather information. Due to its collection methodology, NASS/CDS contains a very large contingent of minor injuries (Maximum Abbreviated Injury Scale - MAIS 1-2) but relatively few moderate, severe and fatal injuries (MAIS 3-6).

Detailed occupant and injury outcome information is limited.

The Crash Injury Research Engineering Network (CIREN) is a crash injury collection network operated by the NHTSA. It is sponsored primarily by NHTSA with assistance from several automotive manufacturers. The cases collected by CIREN are screened from trauma admissions to eight Level 1 Trauma Centers across the US and must meet set injury and crash criteria. CIREN collects very detailed occupant injury and medical information; it also collects detailed crash and vehicle data using NASS-derived protocols. CIREN cases undergo multi-disciplinary review of crash, vehicle and occupant injury data to determine injury causation mechanisms. While CIREN gives unprecedented detailed data regarding injured vehicle occupants and heretofore unavailable insight into mechanisms of injury causation, it is resource- as well as manpower-intensive and relatively costly. Due to its collection methodology and injury severity requirement for entry, the CIREN database contains detailed information on a large number of serious injuries; however, because it is outcome-sampled, CIREN data cannot be used alone to predict risk of injury or, as it now functions to provide an early assessment of the effectiveness of safety technologies, as they are newly introduced into the vehicle fleet.

The University of Michigan Program for Injury Research and Education (UMPIRE) has been a member of CIREN since its inception; UMPIRE has also been an enthusiastic user of NASS/CDS data as an essential complement to its CIREN work to improve motor vehicle safety. Recently, there been a large increase in the number of vehicles on US roadways equipped with Advanced Automatic Collision Notification (AACN) capabilities. At the same time, vehicle development cycles have become progressively shorter, increasing the need for fresh real-life crash data to assess the safety efficacy of recent vehicle design changes. We therefore sought to collect crash cases of interest that would likely escape NASS/CDS or CIREN collection by combining the national reach of a vehicle telemetry service provider and automotive manufacturer with the research capability of medical research group (UMPIRE) based at an independent university. The use of AACN allows the rapid detection of relatively rare crashes of interest nationwide so that communication can be established to obtain informed consent for vehicle inspection and study participation. The use of university-based medical researchers provides assurance to the study subject that their confidentiality is preserved and also allows the collection of comprehensive injury and medical imaging data files. Procedures were developed that prevent the telematics provider and automotive manufacturer from being able to link collected research data with any specific vehicle owner or occupant so as to protect confidentiality.

This paper describes our initial medical experience with this pilot project.

OBSERVATIONS

Subject Recruitment

As per the protocol approved by the University of Michigan Institutional Review Board (IRB), UMPIRE adheres to very strict guidelines during the process of establishing contact with potential study subjects. The telematics provider makes initial contact with the vehicle occupants to determine their interest in becoming subjects. The contact information of those occupants agreeing to participate is then forwarded to UMPIRE staff. Once with the UMPIRE staff, neither the telematics provider nor the vehicle manufacturer have any further contact with, nor do they receive any information about, the individual potential subjects. In order to protect subject privacy, if contact is not established within ten days, no further attempts are made. The number of phone call attempts is also strictly limited. Adhering to these guidelines, we have been able to contact and interview over two-thirds of potential study subjects. To date, only 6% of the individuals contacted have declined participation beyond the initial description of the proposed research and screening.

The overwhelming majority of individuals contacted have been receptive and cooperative with the initial screening interview. Many of the subjects volunteered very positive comments regarding the fact that the manufacturer and telemetry services provider had facilitated such a project to assess the field performance of their products.

The initial interview allows UMPIRE to efficiently determine whether the crash event and study subject met our inclusion criteria. One unanticipated finding

was the large number of crashed vehicles which had already undergone repair or were undergoing repair at the time of the subject interview. At the current time, our study requires an independent investigator to examine and photograph the damaged vehicle to supplement and corroborate the AACN vehicle telemetry sent during the crash event; therefore, subjects whose vehicles were undergoing repair or already repaired were dropped from the study. Changing the day of week and time of attempted initial contact with potential subjects has helped increase the proportion of subjects contacted before vehicle repair. If vehicle inspection and photographic documentation is not necessary once the relationship between crash telemetry and vehicle damage has been confirmed, this problem with vehicles unavailable for inspection will no longer be a concern. In future, if studies target more severe crashes where a greater proportion of vehicles are considered beyond repair, this problem will be less significant. Since the rate of injury observed in the potential study population has been quite low, the option of increasing the AACN crash severity criteria for study inclusion seems reasonable.

Documentation of Informed Consent

It is absolutely imperative in research involving human subjects that informed consent of the study subjects is performed by suitably qualified and trained research personnel and that this informed consent be documented in writing. The consenting subject must also receive materials that inform them of their right to withdraw their participation as well as how to do so. We found the logistics of providing written information regarding the research project to the study subject and documenting their informed consent more challenging than initially anticipated. There is a need to contact the study subject early to facilitate vehicle inspection, but this increased the difficulty of getting written materials to the study subject before the initial phone contact. At the same time, prior experience has shown us that sending the necessarily long and detailed informed consent documents to potential subjects without prior personal contact to explain the study purpose and techniques resulted in many of the documents being discarded without reading or consideration.

We found that it is important to have multiple, redundant means of transmitting and receiving written documents to potential study subjects. The addition of express mail services as well as multiple Web-based technologies and services has improved our efficiency in obtaining documentation of informed consent. Simultaneous phone contact to guide the potential study subject through their reading of the informed consent document helps to allay confusion caused by the many formally written clauses required by the IRB.

Medical Records and Imaging Data

Once having obtained documentation of informed consent from the study subjects, we have not encountered any difficulty in obtaining all necessary medical records and complete medical imaging studies such as CT scans and MRI scans. For ease of handling and to facilitate de-identification to protect study subject confidentiality, we request that records be sent in electronic form. Medical imaging studies are stored and sent in standardized DICOM format by medical facilities nationwide. Therefore, transfer of very large data files from complete medical imaging studies performed on consented study subjects has been very straightforward.

This ability to obtain medical imaging files from AACN crashes represents a key source of vital crash information not available from NASS/CDS or CIREN. Medical imaging files such as CT scans performed on recruited study subjects provide tremendous detail regarding the subjects' body characteristics. They also provide great insight regarding the mechanism of any observed injuries. Our work with medical imaging analysis in the CIREN population has demonstrated very clear links between the subject's body composition and their severity and pattern of injury(2-4). NASS/CDS does not currently collect the medical imaging files. While CIREN does collect medical imaging files, the fact that CIREN is outcome sampled means that the body composition information from CIREN imaging studies cannot be used along with CIREN injury data to determine the effect of body composition differences on injury risk in a given crash. Such determination is essential for the development and validation of human body finite element models capable of predicting crash injuries (5).

As anticipated prior to initiation of this study, a large majority of the medical imaging studies that we have obtained have been from study subjects who did not sustain any significant injuries in their crash. This is

therefore the control population needed to determine the effect of body composition on injury risk in a given crash condition. These CT scans provide us with detailed documentation of the subjects' body characteristics as well as any observed injuries and the vehicle telemetry from their AACN system provides us with information regarding crash direction and severity. Taken together, the data from this type of study can provide information that will allow more accurate prediction of injury risk for different crash conditions. This information can be used by EMS systems and trauma centers to deliver optimal post-crash care.

CONCLUSIONS

Motor vehicle crash injuries remain a major global health problem. Real-life crash data that is more timely, detailed and representative is necessary to guide improvements in vehicle safety. Most real-world crash data collection systems in which a small subset of crashes is randomly sampled have very limited numbers of crashes from specific vehicle models and crash conditions. Geographically based census collection systems have the same limitation. Medically based crash data collection systems provide optimal detail and insight regarding injury causation factors and outcomes, but are also biased by being outcome-sampled and expensive. The use of advanced automatic collision notification technology for screening allows researchers to very efficiently identify the subset of real-world crash cases that hold most value for assessment of injury risk or evaluation of vehicle safety performance. Cost effectiveness will increase even further once photographic documentation of crash damage is no longer necessary.

The involvement of independent, academically based medical researchers significantly enhances subject enrollment and enables the collection of sensitive medical records and digital imaging data while preserving subject privacy and protecting confidential personal medical information. The results of such studies hold great potential to enhance post-crash EMS and trauma care as well as the development of human body finite element models that can accurately predict crash injury patterns and risk.

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