THE DEVELOPMENT OF THE CRASH INJURY RESEARCH AND ENGINEERING NETWORK

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ABSTRACT

The Crash Injury Research and Engineering Network (CIREN) has developed a computer database and wide area network for data sharing and analysis among the current seven trauma centers. The computer data base extends NHTSA's National Automotive Sampling System with medical and trauma related variables in a relational/object database system. The medical data includes injury location details, injury subclassification systems and medical images for better bio-mechanical injury evaluation.

Key data elements are migrated to a core repository so that all centers can review the status of case acquisition across the network. Cases, whole or in part, may be migrated between centers so that individual center expertise may be shared in evaluating the cause of injury. Electronic rounds where cases are reviewed simultaneously across multiple centers is possible.

MAIN BODY

History

The National Highway Traffic Safety Administration (NHTSA) has funded hospital-related studies since the 1980's. In 1991, NHTSA initiated the Highway Traffic Injuries Studies. Over the next two years research projects to collect detailed injury information on motor occupants were funded at four level 1 trauma centers. These were:

> R. Adams Cowley Shock Trauma Center/National
>   Study Center for Trauma & EMS
> New Jersey Medical School/University of
>   Medicine & Dentistry
> Children's National Medical Center
> William Lehman Injury Research
>   Center/University of Miami

The Crash Injury Research & Engineering Network (CIREN) was established in 1996. With grants from General Motors, three additional level 1 trauma centers were added:

> University of Michigan Medical Center at Ann
>   Arbor
> Harborview Injury Prevention & Research Center
> County of San Diego, Department of Health
>   Services

General Motors , also, funded the development of the computer network and system herein described.

Overview

CIREN cases are limited to people who are injured in motor vehicle crashes and transported to the participating trauma center. Other selection criteria includes a focus on frontal impacts involving late model year cars (current year less 8), any impact where a child is injured and transported to the trauma center, all fire related cases, and rollover with fewer than two quarter turns. The cases researched by these centers have been instrumental in the understanding of injury profiles associated with and without air bags and "hidden" injuries such as bowel perforations in children.

CIREN crash investigators depend on the participation and cooperation of law enforcement agencies, hospitals, physicians, medical examiners, coroners, tow yard operators, garages, city vehicle pounds, and the individuals involved in the crashes. Cooperation from law enforcement agencies enables CIREN researchers to obtain police accident reports which give key information on the location of the crash and vehicles involved in crashes.

CIREN crash investigators inspect and photograph vehicles, interview vehicle occupants, and inspect and photograph crash scenes in order to collect the core National Automotive Sampling System dataset via a field PEN computer which is subsequently uploaded to an Oracle Database Server. Additional data and crash reconstruction via WINSMASH, a deltav and trajectory calculation

program, are input via a desktop computer directly into the Oracle Database Server. This data is collected independently of medical data collection.

CIREN researcher teams collect and input extensive medical data on the injured occupant as it is obtained during and after his/her hospitalization into the CIREN dataset stored on an Oracle Database Server. The medical data includes text, drawings, x-rays and other pertinent medical images and photographs.

CIREN research teams, crash investigators and, as required, additional experts meet periodically to review their cases and analyze the injury mechanisms. These review conferences associate injuries with vehicle intrusions, occupant contacts and bio-mechanical mechanisms. Additionally, system specific injury subclassification is performed to assist in elucidating injury mechanisms.

The Computer Network

The exchange of crash data among the trauma centers is essential for the sharing of individual center expertise. The first step in data sharing was the creation of a Wide Area Network (WAN). This WAN permits the individual trauma center computers to communicate and provides a back bone for the automatic migration of data from the centers to the central repository. The CIREN trauma centers were added to the NASS WAN and Oracle servers were placed at each center. The WAN is a frame-relay private TCP/IP network running on fractional T1 lines.

Each center is equipped with a Windows NT Pentium II server running Oracle 8.03 with adequate disk space to maintain 500 active cases. Storage includes images and text. A central repository is maintained at the Volpe National Transportation Systems Center (Volpe) in Cambridge, MA. The central repository is a SUN Enterprise 3000 system with optical jukebox with 180 gigabytes of on-line storage.

CIREN Data Set

The CIREN database consists of the NASS data set augmented with medical and injury variables. Oracle version 8.0 is the database engine. The NASS data set contains variables which describe an automotive crash including but not limited to:

- Crash Type
- Vehicle Make, Models and Body Types
- Crash deformation classification (CDC)
- Crush Profiles
- DeltaVs
- Intrusions
- Occupant Contacts

The medical and injury data elements includes tables for

- Co-morbidity
- Diagnostic Procedures
- Complications
- Operative Procedures
- Medical Images
- Disability Measurements
- Emergency Medical Response
- Emergency Medical Treatment
- Vital Signs
- Physiologic Measurements
- Injury Location
- Ventilation Periods
- Intensive Care Unit Stays

Each CIREN case is one injured occupant in a motor vehicle crash. The medical data listed above is linked to the crash data.

The principal table of the CIREN data set is the CIRENINJURY table. The design of this table permits the linking of injuries to its mechanisms, diagnostic procedures, patient history ,vehicle information, etc. The patient's injuries are stored in the CIRENINJURY table and initially coded using the 1990 Abbreviated Injury Scale (AIS). During a coding conference the injury is linked to appropriate subclassification systems, the crash intrusions and contacts, bio-mechanical descriptors and human mannequins. The human mannequins are a set of line drawings of organ systems. Labels and drawings are over-layered on the standard drawings to clarify position and mechanisms. Diagnostic and operative procedures are also linked to the appropriate injury.

The structure of the CIRENINJURY table permits the story of the injury. For example, an A-Pillar intrusion/contact causes a C1 fracture which in turn causes a spinal laceration via a sheer mechanism.

Data Migration

Each center may check the central repository for the current case types within the entire system. The

central repository maintains core elements of every case within the system. Core elements include a preliminary injury list, accident type, vehicle make and model, CDC and the like. Any center may query the central repository , obtaining a list of cases both completed and active. Completed cases may be downloaded and reviewed. An active case may be requested from the originating center.

This core repository permits each center to rapidly look for trends and to compare data.

These functions are possible because of nightly data migration. The data migration algorithms were specifically developed for the NASS system and have ben adapted for the CIREN system. These processes maximize the speed of transfer and the synchronization of data copies across the network. Oracle Replication could not be used as data may be modified across multiple sites at different times. Our migration systems handle partial case ownership within and across centers.

Cross Center Expertise

Each center specializes in certain areas. For example the University of Maryland is expert in the Orthopedic Trauma Association (OTA) classification system, a detailed fracture classification system. Other centers may request their assistance for orthopedic classification of injuries.

The pertinent portions of the case are transferred to the "expert"center for analysis and coding. Both centers may simultaneously review the cases and education seminars around the case may be held across the two centers.

Electronic Rounds

Electronic rounds are the simultaneous viewing of the CIREN data across all centers in real time with the presentation driven by one center. The rounds are a core feature for the increased communication between centers.

Simultaneous data viewing across all centers is accomplished by migrating read only case copies across all the Oracle databases. As the data is local, the data is viewed real time at all the centers, even though driven by a single center. This eliminates the need for large bandwidth for group conferences.

Image Storage

The system stores all medical images, including x-rays, CT scans, etc. within the Oracle database. The images are stored in JPEG2 format. Images are imported directly in the case of digital cameras or through high resolution scanners.

Multiple images are viewable with the text data to assist in analysis and presentation.

Injury Localization

CIREN brings medical professionals and bio-engineers together. The bio-engineer requires a detailed localization of an injury in order to effectively analyze the mechanics and discover new relationships. The CIREN system includes line drawing mannequins which are mapped to area describers so that there are discrete elements linked to the graphic representation of the injury's locale. These discrete elements permit raw data analysis previously unable on the pure graphical representation.

Injury drawings are layered on top of the mannequin and not directly on the mannequin. This is transparent to the user. The injury layers may be added together or "clustered" so that patterns over several patients may be analyzed. This graphic "addition" highlights repetitive patterns, e.g. chest bruising from seat belts.

Conclusion

CIREN's computer system standardizes nomenclature across the seven centers, permits rapid identification of injury patterns, sharing of data and resources. As the system is implemented, the participating trauma centers may use the network to increase communication, share analytical expertise and work closer with bio-engineers. Hopefully, the system will assist in the early recognition of injury patterns and mechanism.