University of Michigan at Ann Arbor CIREN Center

CIREN Program Report

University of Michigan Program for Injury Research and Education

The University of Michigan CIREN team is an integral part of the University of Michigan Program for Injury Research and Education (UMPIRE). UMPIRE's primary purpose is to improve public safety. Research and Education are the backbone of everything we do in pursuit of this objective.

Research

Detection and Analysis of Emerging Injury Patterns

Head Injuries

It is well known that head injuries are among the most complicated and expensive injuries sustained by individuals involved in motor vehicle crashes (MVCs). The UMPIRE team has been working with UM neurosurgeons to try to understand the mechanisms of these injuries as well as how they have changed with the new safety systems in modern vehicles. We have also been working with automotive engineers in the field of head protection to improve vehicle countermeasures that may mitigate head injuries in the future.

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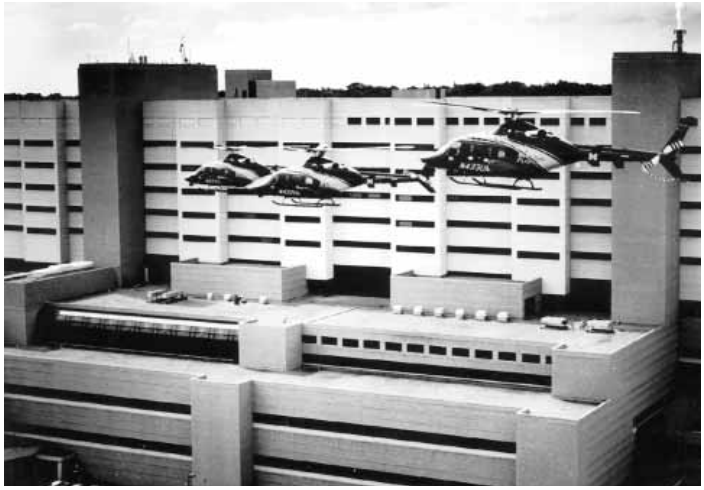
Occupant restraint systems are designed and tuned to control head kinematics and cushion head impacts. In addition, FMVSS 201 and 208 contain head injury potential requirements. Data on how different vehicle, occupant, and crash characteristics affect head injuries in real-world crashes was analyzed to provide insight into current field performance and where the greatest potential is for further enhancing safety.

For both side and frontal impacts, head injury risk was greater for older case occupants and lower for heavier case occupants. Serious head injuries were found to be more common in side impacts than in frontal impact cases, and the pattern of head injury is different for frontal versus side impact cases. Neither the presence of intrusion in the head region nor near side occupant position in offset frontal and side crash cases was observed to be associated with increased head injury risk in our data sample. Among all injury sources, the most common head injury severity was AIS 3. Of interest, airbag contact severities were shifted to either side of AIS 3.



University of Michigan Health System

For frontal impact cases, there were fewer head injuries for airbag only restrained occupants than for seat belt only restrained occupants. Occupants restrained by an airbag and seat belt experienced the smallest number of head injuries. The data also suggests that de-powered airbags offered slightly better head injury protection than full-powered airbags. No comparison of head injury potential to occupants that were not restrained by either a seat belt or

airbag could be made because they were not included in the data sampling.

Since most of the crash cases studied pre-date new regulations that required improved head impact protection, none of the vehicles in our analysis had head countermeasures in place. As new vehicles with these head impact countermeasures are incorporated into the fleet, it will be important to determine if and how these new countermeasures are affecting head injuries.

Knee, Thigh, and Hip Injuries

Late model passenger cars and light trucks incorporate occupant protection systems with airbags and knee restraints. Knee Restraints are designed principally to meet the unbelted portions of Federal Motor Vehicle Safety Standard 208 that requires femur load limits be met in barrier crashes up to 30 mph, +/- 30 degrees. In addition, knee restraints provide additional lower torso restraint for belted occupants in higher severity crashes.

Knee, thigh, and hip (KTH) injuries to occupants of vehicles involved in frontal crashes were analyzed to determine the influence of vehicle, crash and occupant parameters. The data sample consists of driver and right front passengers involved in frontal crashes who sustain significant injuries (AIS > 3 or two or more AIS > 2) to any body region.

Significant KTH injuries are still occurring; and the observed percentage of significantly injured, belted occupants sustaining KTH injuries has not been reduced by newer vehicles. Obviously, reductions in the number of significantly injured occupants from other safety improvements influence this percentage, but KTH injuries remain a problem. Most KTH injuries are occurring within a delta V range no greater than that used for current Federal regulation and consumer information testing. A higher percentage of drivers sustain KTH injuries than right front passengers. KTH injuries still occur with little or no toe pan or instrument panel motion relative to the vehicle.

The data show a higher percentage of belted occupants with air bags and knee restraints sustained hip injuries than belted occupants in non-airbag/knee restraint vehicles. Comparison of the percentage of unbelted occupants sustaining hip injuries in pre- and post air bag/knee restraint vehicles could not be made because the CIREN data base does not contain sufficient numbers of unbelted occupants in vehicles without airbags.

Hip injuries occurring in frontal crashes are predominately acetabular fractures. Hip injuries are generally far more disabling and costly in the long term than thigh and knee injuries. Unexpectedly, these injuries are more frequent among tall male drivers between 150 and 200 pounds of all ages. The rate of hip fracture occurrence increases somewhat with age, but KTH injuries occur in all adult age groups. Hip injuries were more frequent for unbelted occupants, but many belt-restrained occupants also sustained hip fractures. Interestingly, the hip injury tends to occur on the side of the body towards the damaged area of the vehicle and/or principal direction of force.

The results of this study suggest that the current limit on femur loads alone may not be sufficient to address hip injury risk in real-world frontal crashes. They also suggest there is a need for a better understanding of the biomechanics of hip injuries, injury criteria, and related ATD instrumentation.

Increasing Anatomic Injury Detail

In an effort to improve our understanding of injury mechanisms, we feel it is important to record and analyze injuries in as great anatomic detail as possible. The University of Michigan Medical System utilizes the most advanced imaging technologies available today for the care of its trauma patients. As a result, we have three-dimensional records of each study subject's injuries. This 3D radiological imaging system allows us to focus on each injury and follow the path of the forces acting on the body to cause that injury. For instance, in cases where we see a kidney injury, we are able to first look at the kidney itself and slowly add layers of the body back to the image until we have seen the exact location of other associated injuries within the surrounding soft tissues. In this way, we can see from which direction the force came. If we can determine which parts of the occupant's body were struck and where, we can better place the occupant within the vehicle at the time of the crash. We can better determine how the occupant moved in relation to the principal direction of force as well as the mechanisms of injury.

The imaging analysis software also allows us to take measurements in previously unavailable detail. We are able to examine a patient's CT to calculate the breadth of his chest, the thickness of his ribs, and the volume of his lungs. The UMPIRE team has the radiological image data of its CIREN patients. More importantly, UMPIRE also has access to the radiological data of thousands of other patients who may or may not have been traumatically injured. We are in the process of analyzing the body composition data contained in these radiological files to determine the effect of body composition differences on injury tolerance.

We also believe that the 3D radiological imaging system will help engineers in the future. With our access to the uninjured patients, we will be able to compile a database that will better characterize the constantly changing population with respect to height, weight, and body habitus. Since the crash dummies currently used in vehicle testing are based on cadaveric studies done several decades ago, they do not optimally represent the current population as a whole. With the advent of computers and computer simu-

lated crashes, our data will also be invaluable for the development of virtual dummies useful for computer models of motor vehicle crashes and injury causation.

Human Factors in Injury Tolerance

Another of our areas of interest is the elderly population. With our 3D imaging software, we are aware of a number of areas in which the elderly body differs from the young. As people age, it is widely known that bone density decreases. We have also noticed that chest breadth increases.

We have also seen an increase in intra-abdominal fat. Whereas an obese young person has fat located mostly around the outside of the abdominal muscle tissue; the elderly person's fat has migrated inward creating a sort of "packing material" effect.

It is unclear the effect these changes may have on injury causation and treatment. Along with our in depth study on body composition across the population, we are looking closely at the elderly to determine if these changes increase the severity of injuries sustained and how best to prevent these injuries.

Education

Automotive Safety Engineers

It is our belief at UMPIRE that the information collected for CIREN should be disseminated as quickly as possible to the people who will use it. Currently in its second year, our UMPIRE fellowship program has been instrumental in providing automotive engineers with an in depth medical perspective. Our fellows continue to participate on a day-to-day basis with the collection of information for our database. At the same time, they are acquiring the additional expertise needed to augment their understanding of the influence car design has on injury mechanism and prevention. The initial fellows are now back at their sponsoring organizations full-time and are able to instruct other engineers on current trends in MVC injury and the potential influence that this work holds.

What the fellows have brought to the UMPIRE team is no less important. Their knowledge of automotive design allows our medical personnel to gain insights into vehicle interiors and automotive structure that in turn help when treating patients involved in MVCs. The fellows' assistance at our case reviews is invaluable. In many instances, they possess first-hand knowledge of the components within a vehicle interior – what materials they are made from, and the process by which they are created. They are able to tell us why a certain component reacted the way it did to the forces of the crash; they can also tell us if something didn't work the way it was designed to.

Child Booster Seat Education Program

UMPIRE has struck a partnership with the Society of Plastics Engineers (SPE) to develop a Booster Seat Program for elementary schools. The plan is to provide teaching professionals with a kit that includes a curriculum and interactive activities to show children how important it is for them to be buckled up properly. Studies have shown that so few parents and caregivers are aware of the importance of booster seats, we felt it appropriate to educate the parents as well as the children. We have prepared informational sheets to go home to the parents after their children have participated in our program. There are many booster seat programs currently in existence, but we feel what has been missing is the "human element." It is our desire to actively recruit and train people to deliver our booster seat message in as many classrooms as possible within the state of Michigan. In the future, we would like to expand this program to include pediatricians' offices, home daycare workers' licensing bureaus, and county health facilities.