Automatic CRASH NOTIFICATION

The Public Safety Component of the Intelligent Transportation System

Editor's note: This multidisciplinary team of physicians, surgeons, engineers, and crash injury statisticians has been studying methods of improving triage, transport, and treatment of people injured in car crashes. The team examined the latest crash injury data and technologies that can be used to advance emergency medical care for crash victims. This article summarizes the team's findings, significance, and recommendations.

Background

Each year nearly 42,000 Americans die in car crashes. Nearly 20,000 die before receiving hospital care. The fatality figure of 42,000 crash deaths per year is the magnitude of the mortality part of the problem. The morbidity part of the problem, not based on body counts but on national estimates, totals to approximately 5.2 million persons injured in crashes each year, including 2 million disabling injuries per year. The economic costs of crash injuries in the United States surmounted $94 billion in 1994. Each critically injured survivor is estimated to result in an average cost of $706,000. The human costs of tragedy to individuals and families, of course, are greater.

For historical perspective, by 1994 the United States had experienced 3 million crash deaths and 300 million crash injuries—three times the number of Americans killed and 200 times the number wounded in all wars since 1776. By the year 2005, the U.S. Department of Transportation projects that the annual crash fatality rate will rise to 51,000 deaths per year, and as a global phenomenon, vehicular crashes will be a leading cause of death and disability (number 2 and 3, respectively) worldwide.

For fatal crashes in the United States, currently the average prehospital time in urban areas is slightly more than 30 minutes and approximately 1 hour in rural areas. Where trauma systems

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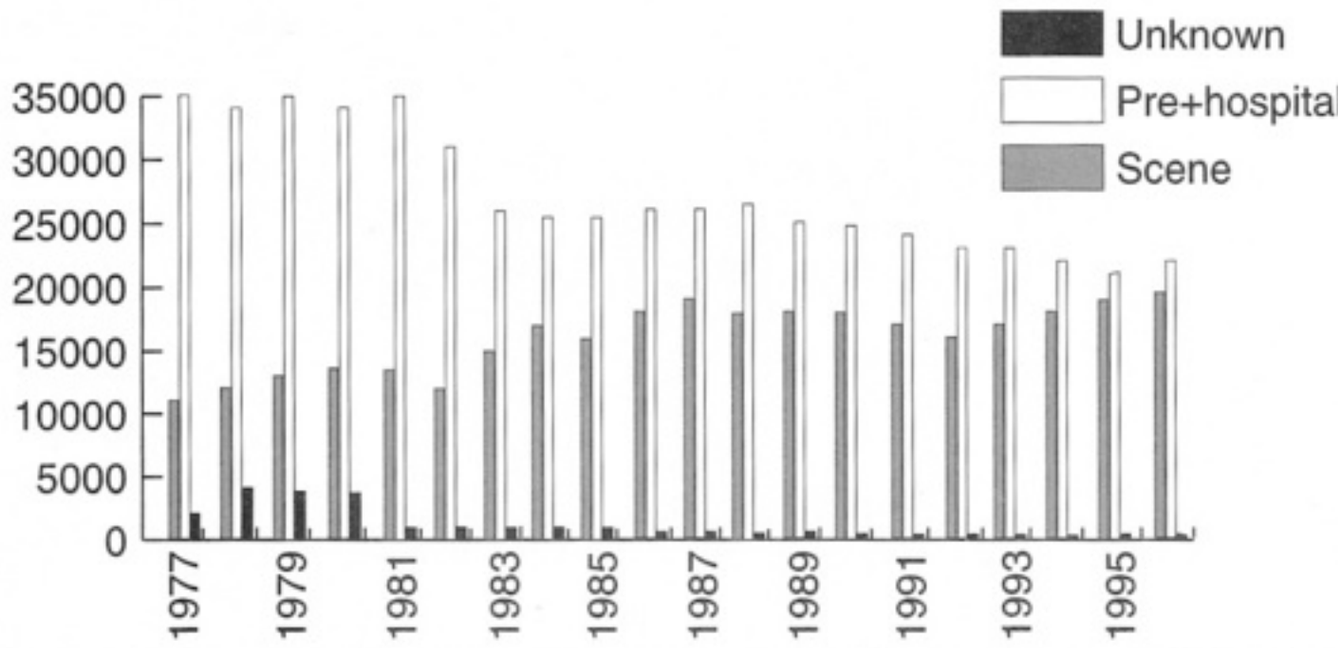
Figure 1: Deaths at Scene vs. Deaths of Patients Taken to Hospital (FARS)



exist, EMS systems use modifications of the mechanism of injury (MOI) triage guidelines, developed by the principal author in the 1980s and still recommended as part of the Advanced Trauma Life Support course offered by the American College of Surgeons, to determine the threshold of injury severity that merits trauma center care rather than the nearest hospital emergency department. These guidelines substantially overtriage individuals who have normal vital signs or do not present with obvious severe and gross anatomical injury. The MOI guidelines are based considerably on attempts to configure a relationship between automobile crash signature (Delta velocity, intrusion, etc.) and anatomical injury.

Findings

Fatal accident reporting system (FARS) data. Automobile crash deaths fell in the United States throughout the 1980s presumably as a result of improved EMS and trauma systems and crash protection and crash avoidance programs. Since the early 1990s, however, the death rate has begun to rise again. And as shown in Figure 1, the number of crash deaths occurring before hospital care now accounts for nearly 20,000 deaths each year.

National accident sampling system (NASS) crash data. These data recently were reanalyzed in an effort to refine the MOI triage criteria. After more than 150 analyses, the team determined that significant improvements could not be achieved and that the discriminatory power of the current MOI (i.e., crash signature) triage criteria has limitations. Meanwhile the problem of crash deaths is mounting. The solution may lie in the combination of emerging and current technologies and automated triage algorithms with the potential for substantially reducing the prehospital time, particularly in rural areas. Using these technologies to more accurately match injuries and available EMS resources now may be possible.

New Technologies for an Intelligent Automatic Crash Notification System

The vision of the intelligent automatic crash notification (ACN) system is to equip each automobile with crash recorder technology that collects crash impact data, such as initial velocity, Delta velocity, and principle direction of impact force. Such information, including the precise location of the crash, can be automatically communicated by impact activation of a cellular phone call to the emergency medical system. This ability to automatically and instantly communicate to the EMS system the location and severity of a crash will significantly improve EMS response and may improve the outcome of many injured patients.

The features of ACN and location will have a major influence on reducing the response time of EMS systems. In addition, the use of an updated triage algorithm, together with scene evaluation by the paramedic, will enable more accurate matching of available local resources with patient need. Thus the timeliness, appropriateness, and quality of EMS responses can be greatly improved with these new technologies.

Automobile location after a crash can be obtained automatically by one of the following technologies:

- **Vehicle-based global position systems (GPS)** with transmission by onboard cellular
- **Triangulated wireless location systems** mounted on cellular phone receiving antennae. A location by triangulation system was tested recently in New Jersey along the lower I-95 corridor. Limited versions of these technologies are being tested on U.S. roads. Many cars already have crash recorders, GPS, and cellular phone systems installed and operational.
- **Ford RESCU system** with the capability for a conscious crash victim to manually call for EMS help, through an intermediary call relay company, by the push of a button. Currently available only on luxury vehicles
- **GM ONSTAR system** with the capability for an automatic call for help through ONSTAR intermediary call relay service. This system is activated automatically in the event of a frontal crash of sufficient severity to

deploy an airbag. Available now on some GM luxury models and soon on a variety of less expensive models

- **National Highway Traffic Safety Administration (NHTSA)/Calspan technology system** with an automatic call for help (using an onboard cellular telephone). The call electronically communicates information on the severity of the crash (for all crash modes: frontal, side, rear impacts, and rollover) in terms of the statistical probability of an AIS 3 serious or greater severity injury being present. This system is being installed by a cellular telephone company in a fleet of 1000 vehicles under a contract funded by NHTSA with Calspan Corporation of Buffalo, N.Y. The Erie County Medical Center is participating in the evaluation of this system.

The multidisciplinary research team developed a triage algorithm for use with the NHTSA/Calspan system that has been named "URGENCY." On vehicle impact, this algorithm immediately reads vehicle sensor measurements of crash forces (Delta V and direction of impact) and automatically calculates the probability of a serious injury (AIS 3+ compelling injuries). Future algorithms will include other parameters, such as belt use, door openings, presence or absence of fire, that will enable additional injury probability messages. (The current algorithm is available in software using Microsoft Excel as URGENCY.xls Version 1.0 from NHTSA or the author.)

These and other new technologies will enable air medical rescue teams to be dispatched sooner and enable all EMS teams to become both more effective and efficient in saving lives and reducing disabilities. We will be able to do our jobs better with more time and better information through faster and smarter emergency responses. These technologies also could be installed in helicopters and have a function similar to transponders and "black boxes" but with more EMS data!

What Needs to Happen

To gain the full benefits of this technology, a national program with medical direction needs to be developed. Leadership, time, people, and money are needed to deliver the lifesaving benefits now possible with these technologies. Systems will have to be modified in all trauma centers/systems to apply this technology, which will involve systems integration of hardware and software, development of new protocols, and training to deliver the benefits of improved triage, transport, and treatment to people in need of urgent care.

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NHTSA, at the urging of the researchers involved in this NASS study, is planning to create an office of postcrash injury control as a means of addressing the EMS problems associated with people who are injured in crashes.

Status of Congressional Funding

The reauthorization of the Intermodal Surface Transportation Efficiency Act, which currently is spending about $200 million per year on an intelligent transportation system (ITS), provides an opportunity to make a major step forward in this initiative. The ITS program has been criticized in Congress for inadequate emphasis on safety. Clearly, postcrash injury control and the intelligent ACN systems are an opportunity to increase safety by providing more prompt and better care for people injured in automobile crashes.

Safety and emergency medical coalitions in Washington, D.C., are requesting funding to develop and test intelligent ACN technologies throughout the United States. The first estimates of the number of potential lives saved by first generation ACN technology (without the triage algorithm) are 3000 lives per year. This number amounts to a 12% reduction in rural fatalities based on the average incident notification time in rural areas reduced from 9.6 minutes to 1 minute. Greater savings should be possible in both urban and rural areas when the technology includes automated triage algorithms on the vehicles connected with computer-assisted dispatch technologies.

An Alliance for Better Communication

The cellular industry has been instrumental in bringing together disparate disciplines behind this issue by forming the COMCARE Alliance, which is composed of nurses, emergency medical technicians, physicians, public safety and health officials, automobile safety groups, law enforcement groups, local communities, wireless telecommunications carriers, and others. The alliance is promoting a public/private partnership with NHTSA to implement the EMS agenda.

To achieve this end-to-end system, the COMCARE Alliance supports using antennae siting fees paid to the federal government by wireless carriers to fund the following integrated programs:

- Grants to states to encourage successful public/private programs to report aggressive and drunk driving and to educate drivers on the full range of driver distractions
- Grants to states to upgrade state and local 9-1-1 systems, including wireless location technology, and to make 9-1-1 the universal number for emergencies
- Development of a universal port to connect all wireless telephones (portable and mobile) to the information systems on board automobiles and to allow hands-free use
- ACN technology that gathers data on the severity of a crash and automatically initiates a wireless 9-1-1 call that includes the location of the automobile
- Development of seamless, reliable wireless emergency communications networks to carry emergency calls and data to the appropriate emergency personnel
- Research using crash data so medical experts can predict the right treat

ment for the injury and immediately dispatch the proper care

The COMCARE Alliance will mount a national public education campaign to demonstrate the need for this end-to-end system and to identify the barriers that hinder system implementation. The alliance also will work with Congress, NHTSA, other administration officials, and state leaders to remove barriers to the deployment of an end-to-end system. Alliance members support federal legislation and will work together in the states to implement it.

The ability to make instantaneous wireless calls for emergency help (with automatic location) has been strongly identified in marketing research, both by the auto industry and the cellular industry, as products and services the public is willing to purchase. One market research study found that 48% of car buyers said that automatic dial 9-1-1 safety equipment is "important" or "very important" in their purchase decisions. The public clearly wants and the technology is now available for an intelligent transportation system that delivers help wherever and whenever Americans are in danger—in time to save lives.

Perhaps the greatest benefits this technology offers to the public and the emergency medical care community is the ability to use the data for continuous improvements in injury prevention and treatment. Crashes, injuries, treatments, and consequences will be studied using automated information systems; science will advance. And we will have a new ability to continuously improve safety and emergency medical care.

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