Advanced Automatic Crash Notification and Intelligent Transportation Systems:
Implications for the Emergency Physician
Policy Resource and Education Paper
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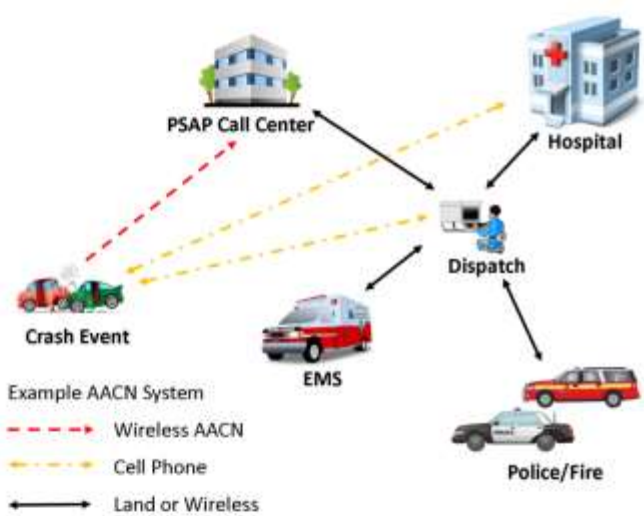
Background

Currently, there are 5.3 million motor vehicle accidents yearly resulting in 2.2 million injuries and 32, 367 deaths. One of the strategic goals of Intelligent Crash Transportation Systems (ITS) is to reduce harm and casualties from motor vehicle crashes (MVC) through the use of advanced automatic crash notification (AACN). The advancing technology with wireless communication, global positioning system (GPS) coordinates and AACN provides real-time information from the scene of a MVC as well as the potential to more efficiently and effectively mobilize emergency medical resources along the continuum of care. As a result, these technologies may improve primary, secondary, and tertiary injury treatment and prevention on the nation's highways and roadways. Specifically, AACN is estimated to reduce road traffic mortality by 1.84% in the US and 2.4-3.8% in South Australia. In addition, AACN may also enhance trauma system patient care delivery by having crash data transmitted simultaneously to the 911 dispatch center and trauma center so that this shared information may help providers prepare and anticipate crash victim injuries.

Historically, emergency medicine has triaged and treated patients with injuries from motor vehicle crashes based on external signs and symptoms that indicate potentially significant internal injuries. However, this task is becoming more difficult as improved crash protection from safer vehicles and restraint system usage has resulted in better safety of the occupant and less obvious external signs of injury. These advancements have improved survival and outcomes but morbidity and mortality still occur.

Although AACN exists, it has not been widely implemented in every car and many emergency medical systems (EMS) are not ready for the integration of crash notification data. In an effort to prepare EMS and 911 medical directors on the use of AACN data, the American College of Emergency Physician (ACEP) in a joint venture with the National Association of EMS Physician (NAEMSP) is developing an online educational training on the use of crash notification data to assist in improving patient outcomes at WWW.AACNEMS.COM. The AACN data can be used to predict the likelihood of serious injury in a crash to improve triage decision-making and EMS resource allocation and utilization resulting in shorter times to definitive trauma patient care. An example AACN system is depicted as follows.



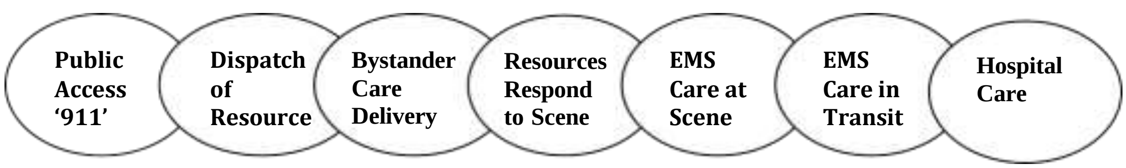
OPPORTUNITY IN RURAL AMERICA – ENHANCING THE *"CHAIN OF SURVIVAL"*

Applications of ITS have focused on transportation needs in metropolitan areas; however, according to several reports by the US Department of Transportation (DOT) Federal Highway Administration, rural areas account for 80 percent of the total US road mileage and 40 percent of the vehicle-miles driven.

A report by the National Association of Development Organizations (NADO) from the US DOT Fatality Analysis Reporting System (FARS) data from 2014 notes that nationwide, 51% of motor vehicle deaths occurred in rural areas. Often rural areas lack access to the appropriate care that may be available in the urban areas. Because of the typically long response times and limited resources available in remote/rural areas, the *chain of survival* is often compromised. For this reason ITS AACN technology integrated into rural/remote America could greatly improve the *chain of survival* in these areas. A validation study showed that AACN data can be transmitted in seven seconds after the collision and a Helicopter EMS can be dispatched to the scene in 3 minutes after the crash.

In emergency medical care, the *chain of survival* concept describes the sequence of events that must occur to ensure the best possible outcome for victims of trauma, cardiac arrest, and other life-threatening situations. The call for help is the first link in this critical chain which is heavily dependent upon victim's level of consciousness and an effective communication system. AACN data and GPS coordinates transmitted from the vehicle itself allows quicker and a more efficient effective first link that does not depend upon the injured person to initiate. Because emergency access via 911 involves over 30,000 calls daily in the United States for EMS, and over 5,000 of these are for motor vehicle crashes, an AACN Occupant Transport Decision Algorithm should be implemented and followed to reduce response time, increase triage efficiency, ensure appropriate resource allocation and maximize patient outcomes. Dispatch of the necessary medical resources (adequate number of EMS providers and ambulances at the needed level of care capability) and efficiently directing them to the scene of a medical emergency and on to the nearest appropriate hospital are of crucial importance. In a study by McKenzie, et al there was a 25% increase in mortality if inappropriately transferred to the wrong trauma care facility.

Emergency Medical Care 'Chain of Survival'



Assuring that the EMS *chain of survival* connects those in need with appropriate resources in the most efficient and effective way is a constant and monumental task. The medical community is one of numerous stakeholders engaged in ongoing strategic planning that will continue to develop and implement an infrastructure to strengthen this *chain of survival*.

BENEFITS OF AACN/ITS FOR THE EMERGENCY DEPARTMENT TEAM

To better define emergency response data priorities an Expert Panel on Advanced Automatic Collision Notification and Triage of the Injured Patient was assembled. This national multidisciplinary panel of EMS leaders, emergency physicians, trauma surgeons, vehicle safety experts and public health officials was selected by the Centers for Disease Control with the purpose of developing a medical protocol for utilization of AACN crash data to better predict severity of injury, thereby appropriately responding to crashes and to triage crash victims. In this report severe injuries were defined as an Injury Severity Score of 15 or greater. Crash characteristics that predicted a 20% or greater likelihood of having a serious injury were considered significant. The following crash characteristics could be transmitted by the vehicle to the health care providers.

Notification that a Crash has Occurred – Activation of the 911 system to assure mobilization of resources to the scene.

Principal Direction of Force (Frontal, Side – Right/Left, Rear) – Probability of injury to the driver and passenger(s) varies greatly with the direction of force(s) impacting a vehicle.

Vehicle-Based Crash Severity Metrics – vehicle change in velocity (delta-v), occupant impact velocity (OIV), acceleration severity index (ASI), vehicle pulse index (VPI) can be used to predict severity of injury.

Restraint Use/Deployment – Reporting whether the driver was restrained, whether additional seats are occupied, and restraint use status has the benefit of notifying dispatch to deploy the necessary resources. Also, EMS providers and the receiving hospital(s) are informed more rapidly of the number of potential victims and their location in the vehicle, enabling them to focus appropriate evaluation and treatment in a more timely manner. Airbag deployment should also be reported.

Vehicle Type (vehicle identification number [VIN]) – Having specific information about each vehicle(s) involved in a crash would increase the accuracy of injury probabilities by identifying which victims were in which vehicle. Knowing the vehicle type, and therefore the weight and safety profile of the vehicle, will help improve injury predictions.

Crash with Multiple Impacts – Knowing the number of impacts can enhance the ability of the injury algorithm to predict likelihood of severe injury. If multiple impacts occur in which the passive safety features of the vehicle (airbags, pretensioners, etc) have been deployed in the initial crash event the victim is at a higher risk of injury with each additional impact to the vehicle.

Other – **Automatic Voice Channel** – Audible interaction between victim (or bystanders offering rescue assistance) and operator (dispatcher) can help confirm injuries, add key data to the triage algorithm (age of victims, treatment priority status, etc.) and alert response teams to additional hazards or difficulties. As a result, dispatchers could provide immediate first-aid instruction, and EMS providers and hospitals will be better informed and prepared to care for potential injuries. As soon as a crash occurs, a wireless voice channel should be initiated automatically so a dispatcher can instantly communicate with them. Several additional data points would also be useful: These include occupant age (>55 years old and young children have increased risk of severe injury), injuries to vehicle occupants, number of patients and number of vehicles involved in the crash. It has also been suggested that it may be feasible to obtain a component of the Glasgow Coma Scale of each of the victims in the crash.

STRATEGIC PLANNING FOR INTEGRATING AACN/ITS TECHNOLOGY INTO EMS SYSTEMS

Issues to be addressed include (but are not limited to) the following:

1) **Identification of useful AACN/ITS technology for integration into EMS systems –**Projects have been conducted by the US Department of Transportation Intelligent Transportation system Joint Program Office Research and Innovative Technology Administration (RITA) (www.its.dot.gov/ng911) throughout the US and the results are collated into the Next-Generation 9-1-1 System reports which makes recommendations in regard to cost, implementation, transition plan and system design.

2) **Involvement of stakeholders (public and private) to support EMS-ITS infrastructure development –** The public sector has representation by areas involving transportation, public safety/law enforcement, local/jurisdictional technical service providers, health/EMS, public policy makers, and others. The private sector has representation from areas involving research and development, automobile manufacturers/sales, trucking firms, third party insurance payers, health

care**,** potential regional technical service providers, emergency communication centers (ERCs), and others.

3) **Development of a standardized content and format for wireless EMS information transmission –** EMS information is to be 'bundled' with other information products so it can readily be disseminated from the scene to end users. Minimum standards for data content and format must be set by public policy consensus to ensure usefulness of EMS information whether it is being managed by commercially marketable systems or by public service systems. Concerns related to incompatibility of different standards, confidentiality, and other aspects of medical ethics need to be addressed.

4) **Development of 'minimum essential' concepts related to the EMS *chain of survival* for inclusion in statewide strategy for individual state DOT ITS Services Deployment Plans –** Statewide strategy must include key concepts for EMS information integration within each state in order to improve the *chain of survival*. This strategy should be a bridge between the national ITS program and deployment at the local level. Issues and needs of EMS need to be succinctly stated in a nationally recognized consensus document that supports the rationale for EMS information integration into ITS within individual state DOT ITS Service Deployment Plans.

5) **Funding for the EMS component of ITS implementation –** Federal funding of projects and in the form of seed money for states to enhance any part of the *chain of survival* is essential. The Enhance 911 Act of 2004 has authorized that 250 million dollars be allocated for enhanced 911 activities. The implementing recommendations of 9/11 commission act of 2007 added another 43.5 million dollars. Continued funding would serve to develop and integrate EMS information systems into statewide strategies. In addition, the New and Emerging Technologies 911 Improvement Act of 2008 encourage transitioning to national IP enabled emergency network. As strategies are developed and implemented, an opportunity should arise for private enterprise to develop and market applications and related interface systems that have the potential for self-funding.

6) **Development of a mechanism to mobilize appropriate AACN/ITS technology into EMS systems and monitor its effectiveness –** The extent role of government to regulate and monitor the industry will need be better defined. Citizens in all areas of the country are to have access to ITS technology integrated EMS systems. It is in rural/remote areas that ITS-EMS integration has the most potential to improve patient access and outcome. Incentives should be created that reduce current jurisdictional barriers and promote sharing of resources related to EMS/ITS technology integration on a local and state level.

FEDERAL GOVERNMENT INVOLVEMENT

Intelligent Transportation Systems is a federal initiative intended to improve transportation safety and efficiency by the use of advanced communication methods and technologies. ITSA (Intelligent Transportation Society of America) was established in 1991 as a not-for-profit organization to coordinate and encourage the development of advanced technologies in surface transportation systems. Although numerous organizations were involved in these problems there was no coordination and no specific attention being paid to the latest technologies. ITSA was authorized by the 1991 Intermodal Surface Transportation Efficiency Act to be a Federal Advisory Committee to the US Department of Transportation. ITSA continued its federal role until 2003. Currently, ITSA has more than 450 member organizations representing industry, universities, research organizations and interest groups. It bridges the gap between the public and private sector as well as advocates to the government USDOT ITS JPO to promote progress in ITS research, deployment and operation. Specifically, concentrating on the following areas:

1. Integrated vehicle based safety systems: all new vehicles equipped with driver assistance systems.
2. Cooperative intersection collision avoidance systems: goals set to implement this system at the 15% most hazardous intersections in the US with in-vehicle support in 50% of vehicles by 2015.
3. Future generation 911 for complete mobile wireless society.

4. Mobility services for all Americans: to demonstrate coordination of transportation needs for elderly and disabled people.
5. Integrated corridor management systems: a model corridor management system to demonstrate how ITS can improve efficiency in movement of people and goods between major metropolitan areas.
6. Nationwide surface transportation weather observation system: integrate weather information from various sources to respond better to roadway problems.
7. Emergency transportation operations: faster and better prepared responses to major incidents and hazmat incidents.
8. Universal electronic freight manifest: more efficient, visible, and accurate freight movement.
9. Vehicle infrastructure integration (VII): communication system in all production vehicles to enable deployment of safety and operational advances.

PARTNERS IN DEVELOPMENT

Suggested roles of public and private groups/agencies in advancing information management for automatic crash notification is as follows.

EMS Information Pathway	Provider	Public or Private
Sending information (intelligent motor vehicles 'smart cars')	Individual Automobile Makers	Private
Decoding information (develop interface compatibility for various ITS modalities including EMS)	Research and Development Companies	Private (with some public seed money support)
Interpreting information* (triage for needed action)	Emergency Communication Centers (ERCs), EDs, Trauma Centers	Private or Public
Dispatching based on appropriate information*	1. Public Safety Access Point (PSAP) dispatch center** 2. Emergency Medical Services dispatch center*** 3. Roadside services/towing dispatch center	1. Public 2. Public or Private 3. Public

* These functions may overlap within same agency based upon local resources and needs.

** Individual PSAPs provide services for law enforcement, EMS, fire, and other public services based upon local jurisdictional needs.

*** Some EMS agencies (typically private) do their own dispatching, even when a local

Summary

Technology advances involving AACN/ITS offer tremendous possibilities to enhance the efficiency and effectiveness of the EMS system through instant crash notification, exact location identification, deployment of appropriate resources, and communication of information related to injury severity potential to dispatch, responding EMS units, and receiving hospitals. The technology to achieve the goal of reducing disability and death must be continuously monitored, evaluated and updated to address the changing and future infrastructure needs.

- **Communication:** real-time transmission of crash injury event and relevant data to enable mobilization of the needed EMS system response

- **Resource availability:** up to date knowledge of what emergency service (public safety, fire and EMS) responders and receiving hospitals (location and ability to receive critical patients) are capable of contributing to the crash injury incident. This includes facilitating arrival of emergency vehicles at the scene through vehicle routing (avoidance of congested traffic, closed roads, etc), identification of vehicles available for service in potentially large geographic response areas, and in vehicle warning systems for safety hazards (train at crossing, police in pursuit, etc.).

- **Data:** involves efforts to assure that the data content is appropriate and that there is format uniformity. This is essential for linkage, evaluation and the development of uniform incident identification codes. Access to data and confidentiality issues need to be clearly defined.

Resources

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