LOCAL EVALUATION REPORT
State of Alabama (2001), Automated Crash Notification System, UAB

I. EXECUTIVE SUMMARY

This project is the pilot phase of a longer-term project to integrate ACN and AACN technology into a comprehensive trauma system. Such a system exists in Alabama's central Birmingham Regional EMS System (BREMSS). The project involves three tasks: the development of an electronic data collection system, EMS data collection in the field, and analysis of collected data for purposes of injury prediction in motor vehicle collisions. Project participants include the Center for Injury Sciences at UAB, the EMS Division of the State of Alabama Department of Public Health, BREMSS and its central Trauma Communications Center, local EMS agencies, and General Dynamics' Advanced Information Engineering Services. Negative institutional issues have been minimal among these organizations primarily due to already existing relationships. These relationships allow most technical issues to be overcome. The greatest challenge experienced to date has been the assessment of data collection tools in the field. Feedback from end users has been limited, and hardware and software configurations (e.g. device size) may be viewed quite differently by different users. One method to overcome limitations to field data collections by EMS personnel is the employment of a trained crash investigator and the development of a system in which data is retrieved from OnStar-equipped vehicles. As the bank of data grows through more equipped vehicles and greater geographical distribution of project activities, injury predictors may be developed and tested against real-world findings.

II. PROJECT DESCRIPTION

This project consists of three tasks that focus on the goal of determining the feasibility of using data collection, communication and modeling technologies to improve the provision of care to patients critically injured in motor vehicle collisions (MVCs). The first task was conducted in conjunction with the Alabama Department of Public Health EMS Division and involved the development and deployment of an electronic data collection system for EMS. The second and third tasks have been pursued in collaboration with Advanced Information Engineering Services, a General Dynamics Company (formerly Veridian Engineering) of Buffalo, New York, a company with extensive MVC and occupant protection research experience. The tasks involve computer based EMS data collection and injury prediction using ACN and EDR data for virtual crash modeling. Using the first task as a platform, the second task is a feasibility trial of collecting EMS data electronically in the field. Task 3 focuses on the role of ACN and EDR in predicting injury occurrence in MVCs.

A. Project Background

Injury is the leading cause of death up to the middle years of life. The impact of injury-related morbidity on individuals and our society as a whole is also significant. The largest contributor to the problem of injury is motor vehicle collisions (MVCs). To effectively address the problem of MVC-related trauma, the provision of timely and appropriate care to critically injured patients is paramount. Despite significant improvements in trauma care and computing technology over the past several decades, the ability to rapidly identify patients in need and to alert and appropriately dispatch emergency medical services (EMS) and direct informed EMS providers to the collision

site, and further, transport a critically injured patient to a trauma center with the appropriate resources to care for that patient all in a real-time and organized environment, does not presently exist. These issues are all crucial to the expected outcome among persons sustaining major trauma. Research has continually demonstrated that time is a crucial factor in determining the likelihood of surviving a critical injury. In the past several decades there has also been a body of research to suggest that organized systems of trauma care can have a significant impact on outcomes in trauma patients. To date, the majority of trauma systems are static in that individual hospitals are recognized as trauma centers and classified according to the level of care they can provide to critically injured patients. Pre-hospital EMS providers, upon identification of a patient with major trauma, are then able to transport that patient to the nearest trauma center. The limitation of such a system is that, at any given moment a particular trauma center may not be fully able to care for a patient with critical injuries due to an overload of resources at that moment in time. A trauma system that continually monitors the resource status (i.e., the availability of specific patient care-related resources) of each trauma center and utilizes this information to assist pre-hospital EMS providers in the appropriate routing of patients would represent a significant advancement in the provision of care to critically injured patients. Such a trauma system presently exists in several areas of the state of Alabama.

With a trauma system in place within the state of Alabama and research to demonstrate its effectiveness, the enhanced development of the system into the pre-hospital environment is a logical extension. One of the primary limitations of the pre-hospital setting is the movement and translation of information in a manner that can positively impact patient care. The emergence of new technology, specifically Automatic Crash Notification (ACN) devices (i.e., automated transmission of event data recorder information), represents a unique opportunity to develop a dynamic trauma system that can identify patients involved in MVCs who have a high probability of sustaining serious injury and ensure the delivery of appropriate care both in the field and in the hospital.

B. Level and Types of Integration

Integration in this project is threefold. The first step is enhancement of the current system of collecting EMS data in the state, conducted in conjunction with the EMS Division of the State of Alabama Department of Public Health. This task provides a platform for integrating real-time EMS data from the field with a trauma system that can triage critically injured patients to the most appropriate trauma center. This step directly relates to the second integration step of conducting a field operational test with selected EMS providers in order to assess, among other things, hardware and software tools of data collection. This pilot test provides useful insight as to the appropriateness and utility of this technology in an EMS environment. Perhaps more importantly, the field operational test produces data used to evaluate the feasibility of using Mayday information from vehicles involved in MVCs as a triage tool. Thus, the third integration step focuses on the role of ACN and vehicle electronic data recorders (EDRs) in predicting MVC injury in near real time.

C. Institutional Involvement

To accomplish the goals of the project, the proposal brings together both public and private entities with experience in the areas of trauma care, information technology, and trauma research.

Specifically, the partners participating in this project with the University of Alabama at Birmingham Center for Injury Sciences are the Alabama Department of Public Health (ADPH) EMS Division and Advanced Information Engineering Services, a General Dynamics Company (formerly Veridian Engineering) of Buffalo, New York. Specific area EMS providers, as well as the Birmingham Regional EMS System's central Trauma Communications Center, are also participants. At the close of this pilot phase the potential to extensively supplement EMS provided data was recognized by the imminent involvement of OnStar, Inc. The project is carried out under the auspices of the Alabama Department of Transportation.

III. EVALUATION PLAN

A. Goals, Objectives, and Measures of Effectiveness

The project has three tasks that focus on the goal of determining the feasibility of using data collection, communication and modeling technologies to improve the provision of care to patients critically injured in MVCs.

Task 1: The State will transition to an electronic data collection system. In the first phase of the transition, the system upgrade will eliminate the portion of the PCR that is made electronic. (The portion of the PCR that is left at the hospital will remain a paper form.) At the completion of each shift, data pertaining to each EMS-patient interaction will be entered into a networked database located at each EMS provider home base. Information from computer assisted dispatch (CAD) systems will automatically create records so that incident numbers, call and dispatch times will be pre-entered into the database. On a regular basis, information from each individual provider will be uploaded to a central database using one of several potential technologies (e.g., modem).

Task 2: Field operational test of the electronic data gathering hardware/software tool configured for EMS provider use. EMSIS (EMS Information System) is a hand-held computer based data collection package provided by Grayco Systems of Hattiesburg, MS. A set of EMS providers is given handheld systems to collect PCR data while in the field. Specific tasks for the field operational test are as follows:

1. Provide a set of handheld data entry devices
2. Customize the software for Alabama EMS purposes
3. Develop interface software for generating, printing and downloading Alabama PCR data
4. Support the handheld units in the field, e.g., maintenance, replacement, modification, etc.
5. Analysis of the field operation trial, e.g., user friendliness, data transfer effectiveness, institutional issues, health care system benefits, patient benefits, etc.

Task 3: Development of tools and techniques for MVC occupant injury prediction. Specifically, requirements for this task are:

1. Develop strategies and protocols to guide the occupant crash modeling activities for crashes involving EDR-equipped vehicles and non-EDR-equipped vehicles
2. Assemble and install computer models to support analyses
3. Identify and acquire test data (e.g., full scale crash test data) to support analyses
4. Interact with equipment manufacturers to allow downloading of EDRs
5. Develop EDR downloading hardware and software as needed
6. Simulate EDR crashes using the MADYMO and ATB occupant crash modeling software tools

7. Correlate injury predictions with real injuries from EDR crashes
8. Analyze crash triage and emergency medical treatment for potential improvement due to EDR based real-time injury prediction
9. Analyze potential improved patient outcome benefits due to real-time injury prediction

B. Hypotheses

With a trauma system in place within one area in the state of Alabama and research to demonstrate its effectiveness, the enhanced development of the system into the pre-hospital environment is a logical extension. One of the primary limitations of the pre-hospital setting is the movement and translation of information in a manner that can positively impact patient care. The emergence of new technology, specifically Automatic Crash Notification (ACN) devices (i.e., automated transmission of event data recorder information), represents a unique opportunity to develop a dynamic trauma system that can identify patients involved in MVCs who have a high probability of sustaining serious injury and ensure the delivery of appropriate care both in the field and in the hospital. Such a system would enhance not only the current advances in trauma care but also capitalize upon current and developing information system technologies. The impact of such a dynamic trauma system is likely to be broad. Improvements in patient outcome are a clear and necessary consequence. Given that Alabama and most other predominantly rural states have elevated crash mortality rates, rapid identification of MVCs will almost surely result in reductions in mortality. Benefits are also likely to extend to other areas of MVC research including a better understanding of occupant kinematics during an MVC. It has been demonstrated that Event Data Recorder (EDR) (vehicle "black boxes") information can be used to model occupant kinematics during a collision. These models can be used to predict the likelihood of particular injuries. If based upon real-world collision parameters and validated against actual observed injuries, such knowledge would not only benefit vehicle design but also the ability of ACN-EDR technology to notify EMS systems that a scene crew is needed and hospital personnel of the potential likelihood of severe injury.

C. Additional Elective Activities Performed
1. Evaluate the institutional issues associated with achieving cooperation among public sector agencies, and document how they were overcome.

2. Provide a brief lessons learned report on the technical and institutional issues encountered in integrating ITS components.

IV. EVALUATION FINDINGS

This project represents the pilot phase of a longer-term effort to integrate ACN technology into an established trauma system while simultaneously enhancing and expanding that trauma system. Progress during this initial phase was such that broader integration continues to be pursued.

A. Project Outcome Based on Measures of Effectiveness

Task 1: Transition to an electronic data Patient Care Report (PCR). The EMS Division of the State of Alabama Department of Public Health established a platform by which most EMS providers in the state can electronically document patient interaction on a regular basis. These widely distributed records become part of the central Alabama Trauma Registry database. The

database is managed collaboratively by the ADPH and UAB. This PC-driven system lays the foundation for extending technological assistance into the field.

Task 2: Field operation test of handheld data collection devices.

1. Provide a set of handheld data entry devices. A limited number of handheld data collection devices were distributed to EMS personnel. The devices were smaller than those originally planned for, yet they contained equal or greater processing power. The smaller size of the device added to its portability and led to it being readily accepted by some personnel while rejected by others.
2. Customize the software for Alabama EMS purposes. The software vendor, Grayco Systems of Hattiesburg, MS, created a flexible package that could be adjusted to a PocketPC or Palm computing environment. The vendor developed the software through collaboration with EMS personnel and the Center for Injury Sciences. The package interface retains characteristics of the familiar paper PCR form.
3. Develop interface software for generating, printing and downloading Alabama PCR data. The flexibility of the platform and handheld software accomplishes this objective. Additionally, an internet web services broker interface for local 911 call centers (Public Service Answering Points – PSAPs) was designed to allow the marrying of EDR-type information from OnStar-equipped vehicles with PCR information collected in LifeTrac, the central trauma communications center's routing decision-making program. This information is immediately available to PSAPs.
4. Support the handheld units in the field. The software designer has made frequent trips to the state to support the hardware/software configuration and fine-tune the interface for individual providers.
5. Analysis of the field operation trial. User friendliness appears to be an easy goal to achieve given the number of mobile tools available and the flexibility of the software, which closely follows the paper PCR. However, user friendliness does not indicate acceptance among EMS personnel who find comfort in established paper practices, or who have varying preferences for the style of data collection device employed. Variation is the consistent theme in analyzing the effectiveness of field data collection. Within an EMS region there are variations in the size and affluence of providers, which lead to different technological capabilities and interest. Within an individual provider, some personnel are more inclined than others to implement new technology. Even the feedback received by interested field testers varies. While it was found that data transferred in this manner can be made effective, the motivation to provide specific, consistent and measurable feedback for analytical and reporting purposes is lacking from some field testers. They may use the devices and they may prefer the devices, yet the amount of feedback that would assist in optimizing device configuration has been less than adequate.

Task 3: Develop tools and techniques for prediction of MVC occupant injury. This pilot study indicates that collision data can be effectively retrieved electronically, allowing for more rapid analysis of information. In order to capitalize on the collected information, a larger sample size is needed. This fact is addressed in subsequent project phases where a broader geographical region is used. Given that ACN information consists of a limited data set, and that Advanced ACN is still relatively new, the task at hand is to continue to collect a sufficient sample size to begin

analyzing trends that could lead to injury prediction and the potential for improved patient outcome benefits. This system is in place. Crash scene investigations and reconstruction by a trained crash investigator, as well as the provision of OnStar information, adds to acquired test data and will enhance the ability to correlate injury predictions and real world outcomes. The mechanism for Task 3 objectives is put in place in this pilot phase, with ultimate results to be realized in subsequent phases as a greater number of automobiles provide the necessary data and a larger geographical area is included in the study.

B. Lessons Learned Report

1. The State of Alabama Department of Public Health can direct and implement a technological initiative within the six individual EMS regions of the state. The tangible technological assets and resulting efficiencies override inherent reluctance to encourage state-led programs among predominately self-governed regions.
2. Technological acceptance can be extended to include equipping individual EMS provider units with virtual electronic PCRs. However, the degree to which providers are willing to actively participate in a controlled assessment of data collection tools is varied. Likewise, the feedback that is received displays variations among what each provider considers vital characteristics of the provided hardware/software configuration. For example, a smaller handheld unit may be viewed as less cumbersome and preferable, while alternatively the device may be viewed by another provider within the same unit as having too small a screen. Potential quantity discounts should be weighed against allowing purchase decisions to be made as locally as possible, with a tendency to grant local authority where possible to increase the likelihood of user acceptance.
3. Technological advancement of hardware units can quickly outpace the ability to equip a large number of providers. Flexibility in the devices to be distributed must be maintained so that the best performing unit at a given price can be employed at any point in time.
4. Software interface should retain as much familiarity as possible with the paper form to increase the likelihood of acceptance.

C. Institutional Issues

This project capitalizes on relationships already in existence prior to technology integration. The newest participant was AIES, and it might be thought that an out-of-state private organization would have trouble fitting into established relationships. However, due to its role as facilitator, trainer, and to some extent motivator among project participants institutional frictions were minimal.

This initial phase of the longer-term project involved integrating the following entities:

Center for Injury Sciences at UAB. The Center for Injury Sciences (CIS) has long been involved in trauma system research and development. The current project is viewed as one more enhancement in pursuit of a truly comprehensive real-time trauma system. Critical to such a system is the flow of data among key players. Overseeing all relative data is the Center's Associate Director. This individual is contracted with the State of Alabama

Department of Public Health, EMS Division, for PCR Management and was instrumental in creating and maintaining the Alabama Trauma Registry.

State of Alabama Department of Public Health, EMS Division: The state provided the platform for creating an electronic Patient Care Report. Its provision of equipment and financial resources during Task 1 allowed the additional key players to proceed with the next steps, and helped overcome burdensome cost-sharing requirements.

Birmingham Regional EMS System (BREMSS): The CIS and BREMSS have worked together often. The directors of both entities meet regularly on project and other issues. The CIS at UAB is the research arm of the only Level 1 trauma center in the region and has been a financial contributor and advisor to BREMSS. These two organizations are in regular communication with AIES.

EMS providers: Communication with local EMS providers is the greatest challenge given the aforementioned differences in resources and interests. While communication with one larger municipal EMS provider was very good, it was not representative of all providers. Some agencies of equal size and affluence were not as eager to integrate new technology, or their management practices made it appear so as responses and actions occurred more slowly. Each agency is a unique entity requiring customized attention.

Advanced Information Engineering Services (AIES), a General Dynamics Company: This organization has been very instrumental in doing much of the necessary legwork and mediating between other participants. In addition to its operational role, it has helped identify other ways in which information could be manipulated for project purposes. For example, it opened dialogue with General Motors' OnStar, Inc., that led to OnStar data being routed through a dedicated server to BREMSS and made available to local PSAPs.