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NATIONAL
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PROGRAM

Emergency Medical Services Response to Motor Vehicle Crashes in Rural Areas

A Synthesis of Highway Practice

TRANSPORTATION RESEARCH BOARD
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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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Emergency Medical Services Response to Motor Vehicle Crashes in Rural Areas

A Synthesis of Highway Practice

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Cover figure: Traffic accident on Highway 9 near New Britain, Connecticut. State troopers, local police, firefighters, paramedics, and a LifeStar helicopter are on the scene. *Credit*: Sage Ross, 2007.

FOREWORD

Highway administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to highway administrators and engineers. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire highway community, the American Association of State Highway and Transportation Officials—through the mechanism of the National Cooperative Highway Research Program—authorized the Transportation Research Board to undertake a continuing study. This study, NCHRP Project 20-5, "Synthesis of Information Related to Highway Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an NCHRP report series, *Synthesis of Highway Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Jo Allen Gause
Senior Program Officer
Transportation Research Board

Motor vehicle crashes on rural roads account for more than half of all highway fatalities in the United States, yet less than one-quarter of the population lives in rural areas. Many factors contribute to the high rural fatality rate, such as the challenge for emergency medical services (EMS) to be notified, locate, respond, stabilize, transport, and care for crash occupants in a timely and effective manner.

This synthesis presents information on the state of the practice for a broad cross section of rural EMS system characteristics. The report identifies factors that may help reduce the time needed to provide effective medical care to crash occupants on rural roads.

Information used in this study was acquired through a review of the literature and a survey of state departments of transportation and EMS offices in 14 states. Follow-up interviews with selected agencies provided additional information.

Erik D. Minge, SRF Consulting Group, Inc., Minneapolis, Minnesota, collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable with the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

EMERGENCY MEDICAL SERVICES RESPONSE TO MOTOR VEHICLE CRASHES IN RURAL AREAS

SUMMARY

According to national highway safety statistics, a disproportionate number of motor vehicle crashes occur in rural areas. About 40% of vehicle-miles traveled occur on rural roads; however, these rural trips account for 54% of all traffic fatalities. In 2010, a total of 18,026 lives were lost in crashes on rural roadways. Several factors contribute to these higher injury and fatality rates, including that rural crashes are more likely to involve higher vehicle speeds, a lower rate of seat belt use, and less availability of timely emergency medical care.

Rural crashes present unique challenges for emergency medical service (EMS) systems. Compared with urban areas, a greater percentage of rural crashes result in multiple fatalities and higher rates of head-on collisions, roll overs, and ejected crash occupants. In addition, rural EMS systems often rely on a volunteer force, and tends to have less financial resources for staffing, equipment, and training. Response times in rural areas are longer owing to the greater travel distances required to reach the scene of a crash. Additionally, some rural EMS systems operate in areas with limited telecommunication options.

This synthesis study explores the state of the practice for a broad cross-section of EMS system characteristics. It identifies factors that affect the timely provision of effective medical care in rural areas. In addition, it examines broader issues such as personnel, data records, and interaction with other agencies.

This synthesis was compiled through a combination of literature review, agency surveys, and follow-up interviews for case examples:

- The literature review included a synthesis of current practices, relevant research, and recent statistics on highway crash rates and EMS response metrics in rural areas. Data collection focused on rural areas, defined as anywhere outside a U.S. Census-defined Urbanized Area with a population exceeding 50,000.
- Surveys were conducted of departments of transportation (DOTs) and EMS agencies in 14 states with high rural crash fatalities in order to explore how emergency medical response is approached by these two distinct groups, and what opportunities exist for improving the response of rural EMS systems. All 28 agencies responded to the survey.
- Five states were selected for follow-up interviews based on their survey responses. Case examples were prepared for both the EMS and DOT agencies in order to capture an in-depth understanding of EMS issues in these states.

Information collected was organized into the following categories:

- Crash Detection/Locating/Reporting—Advanced Automatic Crash Notification (AACN), geographic data sets, and data collection.
- Road Condition Reporting—weather, construction, and maintenance information and the data delivery systems (such as 511 telephone and web services).

- Dispatching—Computer-aided dispatch and Public Safety Answering Point (PSAP) technologies and integration.
- Communications Systems—Interoperable data and voice networks.
- Equipment and Preparation—Predeparture conditions of vehicles and equipment; procedures for ensuring readiness.
- Air Medical Transport—Fixed wing and helicopter use for scene-to-center and center-to-center transport.
- On-Scene and Transport Issues—Management of the crash scene, care, loading, and transport.
- Telemedicine—Use of communications and data collection technologies to provide enhanced medical care at a distance.
- Record Linkages/Data Metrics—Integration and analysis of data relating to crashes, roadways emergency patient care, outcomes and costs.
- Recruiting/Retention/Training—Staffing issues related to EMS and PSAP personnel.
- Tribal EMS—EMS on tribal lands or by agencies operated by tribal organizations.
- Interagency Cooperation and Coordination—Integration efforts between EMS agencies or between EMS and transportation agencies.
- Planning and Innovation—Efforts to develop creative strategies to enhance rural EMS system response.
- Care Protocols and Procedures—Processes used by EMS personnel to provide on-scene and in-transport care.

The following are major findings and lessons learned from this synthesis effort. These findings are based on information obtained from the literature review, agency surveys, and interviews.

- Prehospital times for crash occupants were substantially longer for rural crashes, averaging 25 minutes in urban areas and 42 minutes in rural areas. EMS arrive at the scene within 10 minutes of notification in more than 85% of urban fatal crashes but less than 54% of the time in rural crashes.
- Shorter prehospital times are correlated with lower mortality rates. The Centers for Disease Control and Prevention found that severely injured crash occupants who receive care at a Level I trauma center within 1 hour had a 25% reduction in risk of death.
- All of the 14 focus states have prepared Strategic Highway Safety Plans, but these varied in their emphasis on EMS. Some focused on interoperable communications systems, whereas others had data linkage or scene management components. Five states did not have an EMS component in their Strategic Highway Safety Plans.
- Survey responses indicate that the majority of DOTs in the focus states are actively participating in efforts to improve rural crash response. The survey also revealed that DOT personnel assist with response, primarily through traffic control or infrastructure repair.
- Air medical transport was used to some extent in all states; however, the effects on patient outcomes are not well understood. Research appears to establish that ground transport can have shorter crash to hospital arrival times for distances less than 100 km. Also, the positive effects of air transport appear to be limited to only the most severely injured patients.
- Telemedicine applications are used by roughly one-half of the EMS agencies surveyed. The majority of these transmit biometric data. The data regarding telemedicine's effect on patient outcomes are incomplete. Some studies have found inconclusive results on objective outcome measures, where others have found positive outcomes.
- The precursor to AACN, Automated Crash Notification (ACN), has been shown to produce measurable reductions in the time from crash occurrence to crash reporting.
- Modeling suggests that the use of AACN may be able to reduce notification times to no more than 1 minute and realize up to a 20% reduction in fatalities.
- Although 75% of EMS survey respondents indicated that data were collected about crash details, responses, and injury severity, only three indicated any linkage to hospi-

tal records and one to driver's license data. Almost no cost or compensation data are linked to response or crash records.

- A model system to enable real-time and recorded data to be shared has been deployed in Idaho. This smartphone-based solution has been evaluated in a "production" environment. Systems of this type create electronic records that can be more easily referenced to other data sets.
- Frameworks for linking records between different data sets have been created, notably the National Emergency Medical Services Information System database. Efforts to link these data to other data sets have proven only partially successful and unique identifiers that can easily relate records between different sources do not exist, resulting in data "silos." Statistical matching techniques have been attempted, but have been only partially able to match records.
- More than half of the survey respondents indicated that vehicle or equipment condition has caused delay in an EMS response. However, follow-up interviews revealed that these issues are not endemic and are managed through proper maintenance procedures, such as the inspection criteria used in West Virginia or mutual-aid agreements similar to those in place in Nebraska.
- Three-quarters of EMS survey respondents indicated that EMS responders are volunteer or part time.
- Staffing issues were identified as negatively affecting response times by 75% of EMS survey respondents. Recruitment and retention of qualified personnel were frequently identified as causes for staffing problems.
- According to EMS survey results, 75% of respondents used Global Positioning System guidance systems. However, there is contradictory evidence on the impact of these systems. Some studies have shown there to be no significant difference in mean times to arrival. More recent evidence has shown significant differences when used on trips over five miles.
- Data on issues involved with EMS provided by tribal organizations are sparse. Anecdotal information from EMS interviews indicates improving service, but specific data are not readily available.
- Although all DOTs surveyed indicated that they provide road condition information through telephone (511), web, broadcast media, or mobile applications, only one-third of EMS survey respondents said they could easily access condition information.
- DOTs and EMS agencies have complimentary responsibilities and areas of action when responding to rural crashes. DOTs focus on traffic management and maintenance of the infrastructure, whereas EMS agencies focus on injured crash occupants and their care. In some cases, EMS and DOT personnel may share dispatch facilities or communications equipment, but coordination largely takes the form of organizing related actions, rather than sharing responsibility for any single task.

Several areas of gaps in existing knowledge or conflicting results have been observed and identified. Several areas for future research are outlined here that may improve understanding on EMS response to rural motor vehicle crashes.

- Although evidence suggest that using Global Positioning System guidance can reduce time to arrival on-scene, particularly for longer distance, some agencies avoid using the devices because of difficulties with use or poor-quality geographic data. To address these issues, research into the mapping data used by devices and guidelines for training users could be conducted.
- AACN offers the potential to provide an early assessment of injuries, which can assist providers with predeparture preparation and dispatchers with responder selection (e.g., air transport, rescue units). However, little is known about the long-term reliability of vehicle-based sensors for these applications or AACN's effect on patient outcomes.

- All DOTs provide near real-time information on state-jurisdiction roadways, including construction information and roadway condition. The lack of easy-to-access data for emergency responders may be addressable through improved interfaces and appropriate access devices.
- Interoperable digital communications networks primarily serve voice and low bandwidth data communications functions, which limit some applications such as telemedicine that requires images or audio/video streams. The impact of low bandwidth availability on these applications and the feasibility of enabling higher data rates could be explored.
- With EMS equipment condition or availability identified as a factor in response times, methods for ensuring readiness may be a valuable research topic.
- Use of air medical transport and its impact on patient outcomes does not have definitive evidence; however, patient injury severity, rather than distance, appears to be the factor that benefits most from air transport. Investigation of injury-severity based dispatch using AACN or other inputs may provide a way to maximize the cost-effectiveness of air medical transport.
- There is conflicting information from the literature search on the efficacy of telemedicine in the center-to-center environment. Further studies of objective measures of patient outcomes may provide insight into the viability and effectiveness of telemedicine applications.
- The use of telemedicine in the scene-to-center or mobile telemedicine is dependent on the availability of suitable communications networks to transport the data. Investigation of the limits of data requirements and how these can be met with existing or augmented networks would define the broad parameters of mobile telemedicine uses and limits of deployment.
- A study of existing efforts to collect real-time patient data and link that information to emergency room preparation and other record sets and the impact of this information on patient outcomes would be valuable. A related research need is to connect patient outcomes to cost data to permit cost-effectiveness analysis.
- There appears to be little data on differences in procedures or outcomes between tribal and nontribal EMS providers. Investigation of opportunities to work with tribal governments to assess performance and to enhance services through coordination, unified training or care protocols, and sharing of resources may highlight ways to improve care for patients on or near tribal lands.
- Both DOT and EMS agencies compile a variety of information and statistics related to crashes; additional coordination between these data stewards and additional data collectors (e.g., hospitals) may provide valuable insight into factors and processes that affect patient outcomes.

CHAPTER ONE

INTRODUCTION

DEFINITION OF PROBLEM

Rural vehicle crashes represent a disproportionate number of fatalities, with less than one-quarter of the driving population involved in more than half of crash fatalities (NHTSA 2012). A number of safety initiatives (Toward Zero Deaths, various studies and organizational efforts) have been implemented to reduce the number and rate of fatal crashes in general and in rural areas specifically. In addition to improving the roadway, vehicle systems, and driver behavior to reduce crashes, enhancing emergency medical services (EMS) is a possible avenue to lower fatality rates.

Emergency medical response may be viewed as a sequence of events beginning at the moment of the incident. From there, an interval of time is required for detection, reporting, dispatch, preparation, travel to the scene, triage/evaluation, stabilization, transport to a care facility, transfer to a specialty care center (if needed), and finally the provision of definitive care and rehabilitation. Figure 1 illustrates this EMS sequence and common tasks at each stage.

Improvements to the process outlined previously may help reduce the time needed to provide definitive medical care, and positively affect the ultimate outcome for the patient.

For this synthesis, "rural areas" follows the U.S. Census definition of being outside a U.S. Census-defined Urbanized Area with a population exceeding 50,000. Previous EMS studies (mentioned in the literature review) have used other definitions of rural.

PURPOSE OF THIS REPORT

The purpose of this synthesis study is to document the current state of the practice, strategies that have been identified as effective, and deficiencies in emergency medical response to motor vehicle crashes in rural areas. Some of the information captured in this study includes—

- Measurable quality of care and outcomes
- Collection and analysis of response and transport times
- Evaluation of cost-effectiveness of EMS practices
- Integrated partnerships between key stakeholders
- Technology used to improve EMS performance
- Innovative training and recruitment strategies.

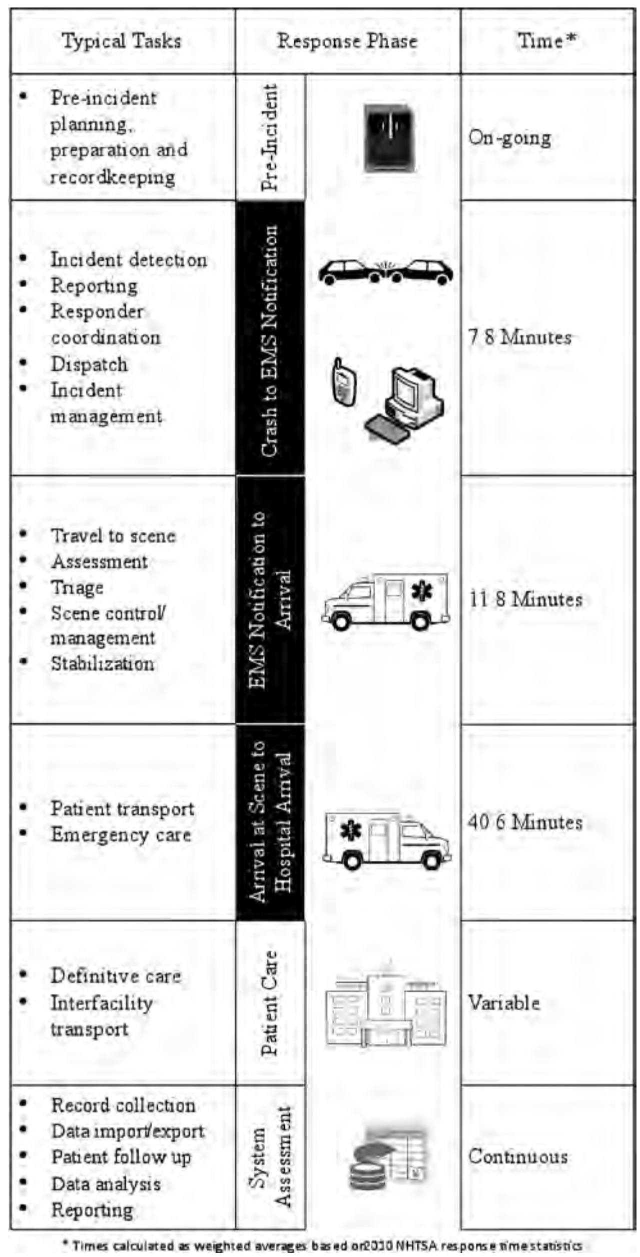

FIGURE 1 Rural EMS response sequence.

This synthesis study also identifies current knowledge gaps and recommends opportunities for further research.

PROJECT METHODOLOGY

This synthesis was compiled through a literature review, agency surveys, and case examples:

- The literature review included a synthesis of current practices, relevant research, and the latest statistics on highway crash rates and EMS response metrics in rural areas.
- Surveys were conducted of both departments of transportation (DOTs) and EMS agencies in selected states with high fatality rates on rural roadways. These surveys explore how emergency medical response is approached by these two distinct groups, and what opportunities exist for improving EMS. The survey was administered online to DOTs in Arkansas, Iowa, Idaho, Kansas, Kentucky, Mississippi, Montana, Nebraska, New Hampshire, South Carolina, South Dakota, Vermont, West Virginia, and Wyoming. All 28 agencies responded to the survey.
- Five states were selected for follow-up interviews based on their survey responses: Arkansas, Idaho, Nebraska, Vermont, and West Virginia. Case examples were prepared from both the EMS and DOT agencies in order to capture an in-depth understanding of EMS issues in these states.

INTENDED AUDIENCE

This synthesis report will be of particular interest to managers of EMS programs throughout the country. Typically, state and local EMS officials comprise a small component of a larger department, often a health department, and are often dealing with issues that are unique to EMS. The information in this report will connect these managers with the EMS challenges and opportunities faced by other states. DOT officials will also find the contents of the synthesis of interest when designing and assessing roadway safety and incident management programs.

The report should also be of interest to DOT staff who are involved in traffic safety, operations, and maintenance of roadway infrastructure.

ORGANIZATION OF THIS REPORT

Following this introduction chapter, this synthesis report is organized into four remaining chapters: Literature Review, Survey Findings, Case Examples and Conclusions. A reference section is followed by appendices that provide the survey questionnaires, interview guides, and the raw survey numerical results.

CHAPTER TWO

LITERATURE REVIEW

INTRODUCTION

Improvement of EMS performance is a subject of ongoing study across the United States and around the world. The objective of this task is to conduct a national search of available literature and synthesize the information relevant to this topic. This literature review provides background statistics as well as specific practices and metrics used by EMS personnel and health care facilities.

Literature was reviewed from various sources, located through online searches, publication databases such as PubMed, existing study bibliographic information, and recommendations by the project panel. In general, documents were limited to the previous 15 years to minimize the influence of out-of-date information. Several categories of documents were obtained directly from state government online sources, including:

- Toward Zero Deaths plans/Strategic Highway Safety Plans
- Interoperable Communications Plans
- State reports on vehicle crashes (Crash Facts and similar documents).

The U.S.DOT's Research and Innovative Technology Administration database of deployment statistics was used as a source of information for deployments of transportation-related emergency response systems. This information was used to guide searches for documents from other sources and to review the relevant activities in the states included in this synthesis.

Documents were compiled by SRF Consulting Group staff and categorized for review. Staff members were then assigned several categories for a detailed evaluation and summary. Information in this chapter includes a summary of crash statistics on rural areas, a summary of EMS crash response data, and a synthesis of literature related to EMS crash response in rural areas.

RURAL CRASH STATISTICS

The majority of motor vehicle travel in the United States takes place in urban areas. Despite a greater number of rural road miles, more than 60% of total vehicle-miles traveled (VMT) on public roads occurs in urban areas (1.7 VMT in trillions); only 40% of VMT occurred in rural areas (1.1 VMT in trillions) (FHWA 2002).

Although more motor vehicle travel takes place in urban areas, rural areas account for more than half of the nation's fatal crashes. In 2010, rural areas reported more than 16,000 (54%) fatal crashes that resulted in 18,026 fatalities. Urban areas experienced more than 13,600 fatal crashes (45%) and 14,546 fatalities (NHTSA 2012). The 2010 fatality rate per vehicle miles traveled was two-and-one-half times higher in rural areas (1.83 per 100 million VMT) than in urban areas (0.73 per 100 million VMT) (NHTSA 2012). Although crash rates in general have been declining over the past 10 years, the discrepancy between rural and urban rates remains an issue, as illustrated in Figure 2.

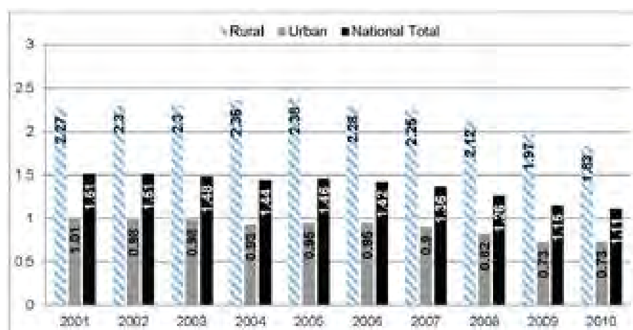

FIGURE 2 Fatalities per 100 million VMT by year and location (*Source*: NHTSA 2012).

Several factors appear to contribute to higher fatality rates in rural areas, including differences in travel speeds, use of seat belts, and proximity of emergency care. Rural areas with higher speed limits account for the most fatal crashes (NHTSA 2010). Nearly 70% of fatal crashes in rural areas occur on roads with speed limits greater than 55 miles per hour (mph) whereas most fatal urban crashes, however, occur on roadways with speed limits of 50 mph or less (NHTSA 2010). Rural roadways may also lack the safety features of urban roadways, such as wide shoulders, lighting, and guardrail/curb systems. Table 1 illustrates the relationship between speed limit and fatal crashes in urban and rural areas.

Seat belt use and vehicle type also contribute to the disproportionately higher fatality rates in rural areas. In 2009,

TABLE 1
VEHICLES INVOLVED IN FATAL CRASHES BY SPEED LIMIT AND LAND USE

	Land Use							
	Rural		Urban		Unknown		Total	
Speed Limit	Number	Percent	Number	Percent	Number	Percent	Number	Percent
30 mph or less	999	4.2	3,321	16.0	56	13.4	**4,376**	**9.8**
35 or 40 mph	2,143	9.1	5,317	25.7	64	15.3	**7,524**	**16.8**
45 or 50 mph	3,743	15.9	4,883	23.6	112	26.8	**8,738**	**19.5**
55 mph	9,988	42.3	2,787	13.5	143	34.2	**12,918**	**28.9**
60 mph or higher	6,025	25.5	3,339	16.1	25	6.0	**9,389**	**21.0**
No Statutory Limit	85	0.4	89	0.4	4	1.0	**178**	**0.4**
Unknown	616	2.6	960	4.6	14	3.3	**1,590**	**3.6**
Total	**23,599**	**100.0**	**20,696**	**100.0**	**418**	**100.0**	**44,713**	**100.0**

Source: NHTSA (2010).

55% of persons killed in rural crashes were unrestrained compared with 50% of those killed in urban crashes. Furthermore, nearly 70% of rural pick-up truck occupants killed in crashes were not wearing seat belts, making it the highest percentage of any passenger vehicle occupants killed among both rural and urban areas (NHTSA 2009).

RURAL CRASH RESPONSE STATISTICS

Rural EMS is provided through a variety of service delivery components and methods across the nation. A network of EMS personnel, including volunteer and career emergency medical technicians (EMTs) and paramedics, use various vehicles, equipment, and facilities to deliver emergency medical care to injured occupants of rural crashes (Knott 2003).

After a severe motor vehicle crash, the crash occupant's survival may ultimately depend on how quickly they receive definitive medical treatment. Dr. R. Adams Cowley is credited with coining the term "golden hour" to refer to the 60 minutes immediately following the occurrence of multisystem trauma event. However, a rigidly defined 60-minute interval for survival has since been scrutinized and the relevance of this timeframe is not supported by research. The time-dependency of a successful outcome is dependent on various factors, including the type of injury that has been sustained. Additionally, the literature is not clear on how time sensitive the delivery of definitive medical care is on patient outcomes. For example, research has not established that a clinically significant outcome is correlated with a given reduction in time in delivering definitive medical care. A related issue is the significance of the time required for an EMS unit to arrive at the scene (often measured in minutes) as compared with the significance of the time required for the patient to arrive at a facility that can provide definitive medical care (often measured in tens of minutes or hours).

While a "hard" limit of 60 minutes is not regarded as crucial in decreasing patient mortality/morbidity rates, and the time sensitivity that correlates to clinically significant outcomes is not understood, there is general consensus that reducing the time from the occurrence of a motor vehicle crash to the delivery of the patient to definitive medical care has a positive impact on patient outcomes. For example, the Centers for Disease Control and Prevention (CDC) found that severely injured patients who receive care at a Level I trauma center had a 25% reduction in risk of death (NASEMSO 2010). The CDC source also emphasized the importance of timely access to trauma facilities, but did not place specific limits on time.

What is well documented is that response times are longer in rural areas than in urban areas. Furthermore, more than 36% of rural fatal crashes exceed the "golden hour," meaning it takes more than 1 hour for injured crash occupants to receive hospital care after the crash has occurred. This figure compares with 10% of urban fatal crashes that take an hour or more to receive hospital treatment. Table 2 shows the average EMS response time for crashes in which at least one person died is presented for urban and rural areas.

Delays or greater response times in rural areas are often related to increased travel distances. Significant delays may also occur as volunteer EMS personnel may travel first to the EMS station to retrieve the ambulance. In addition, rural areas without well-designed trauma systems may experience further delays in moving severely injured patients from rural hospitals to trauma centers.

LITERATURE REVIEW AND SUMMARIZATION

Fifty documents were reviewed for their relevance to the topic area. Of these, the major findings for 37 are summarized. Each literature source was categorized into one of the 10 topic

TABLE 2
FATAL CRASHES BY EMS RESPONSE TIMES WITHIN DESIGNATED MINUTES AND BY LAND USE

Response Time (Minutes)	Time of Crash to EMS Notification		EMS Notification to EMS Arrival		EMS Arrival at Scene to Hospital Arrival		Time of Crash to Hospital Arrival	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Rural Fatal Crashes								
0 to 10	7,340	86.5	4,875	53.8	85	2.0	12	0.3
11 to 20	682	8.0	3,027	33.4	515	12.0	119	2.9
21 to 30	213	2.5	744	8.2	1,073	25.0	427	10.3
31 to 40	98	1.2	273	3.0	943	22.0	649	15.7
41 to 50	35	0.4	83	0.9	664	15.5	752	18.2
51 to 60	42	0.5	25	0.3	421	9.8	671	16.2
61 to 120	75	0.9	40	0.4	594	13.8	1,507	36.4
Total*	**8,485**	**100.0**	**9,067**	**100.0**	**4,295**	**100.0**	**4,137**	**100.0**
Urban Fatal Crashes								
0 to 10	6,685	94.2	5,994	85.3	208	5.5	32	0.8
11 to 20	255	3.6	857	12.2	1,104	29.1	438	11.6
21 to 30	62	0.9	125	1.8	1,247	32.9	1,076	28.5
31 to 40	25	0.4	37	0.5	662	17.4	912	24.1
41 to 50	11	0.2	7	0.1	293	7.7	602	15.9
51 to 60	18	0.3	3	0.0	122	3.2	329	8.7
61 to 120	39	0.5	2	0.0	158	4.2	393	10.4
Total*	**7,095**	**100.0**	**7,025**	**100.0**	**3,794**	**100.0**	**3,782**	**100.0**

Source: NHTSA (2010).

areas used here. For larger documents, a summary of contents is included as opposed to providing detailed information.

Dispatching

The efficacy of using a Global Positioning System (GPS) in EMS vehicles as a means of reducing response times was explored by researchers in "GPS Computer Navigators to Shorten EMS Response and Transport Times" (Floyd et al. 2001). Researchers conducted a two-part test of GPS effectiveness. The first part used nonemergency vehicles in pairs, sent from the same origin at the same time to the same destination. One vehicle used a GPS device, the other did not. The second part placed the device in an EMS vehicle with a crew of either one EMT and one paramedic or two paramedics.

The first part test runs revealed that there was no significant difference in distances traveled by the two vehicles. However, there was a significant difference in the meantime to arrival (13.5 minutes versus 14.6 minutes). The authors state that the GPS guidance appeared to have a greater effect at night when roadside signs are more difficult to see and where complex traffic patterns (involving one-way streets) are present. The second part interviews indicated an even split between respondents who found the device useful or somewhat useful and those who rated the device not useful on actual response runs. When asked if the device might be useful in areas where geographic familiarity is poor, all responded that GPS provided benefits. The authors concluded that GPS guidance can reduce travel times and that reductions in time will improve as users become more familiar with operating the device.

A more detailed study of rural EMS response using GPS guidance was conducted in "Improving Rural Emergency Medical Service Response Time with Global Positioning System Navigation" (Gonzalez et al. 2009). Researchers equipped ambulances with GPS devices and recorded trip times for a 1-year period in a rural county in Southwest Alabama. The data were collected from both GPS-equipped and nonequipped vehicles and trips were aggregated by total length to the scene to make them comparable for time. Data were all aggregated based on whether the incident involved a motor vehicle crash or not. The authors found that GPS-equipped vehicles had shorter travel times in nearly all cases, with longer trips showing greater advantages. Table 3 summarizes the travel time differences.

The authors conclude that rural EMS travel times can be significantly shortened by the use of GPS guidance devices. They also note that limitations of such devices, such as out-of-date mapping data and loss of GPS signals as a result of obstructions or system malfunctions, can affect performance and should be considered when deploying GPS guidance.

TABLE 3
OVERALL MEAN EMS RESPONSE TIME GROUPED BY MILES TRAVELED

	With GPS		Without GPS		
EMS Miles Traveled to Scene	No. Calls	Mean Response Time (min)	No. Calls	Mean Responses Time (min)	*p* (t test)
2–5	518	5.1	627	5.3	0.03
6–10	164	8.7	143	11.1	<0.0001
11–15	44	13.3	56	16.3	0.0004
16–20	40	19.1	39	21.3	0.004
>20	25	23.5	28	32.1	<0.0001

Source: Gonzalez et al. (2009), Table 3.

Record Linkages/Data Metrics: Real-Time Data Communications and Management

Efforts have been made to integrate computer-aided dispatch with the traffic management systems used in Traffic Management Centers (TMC). *Computer-Aided Dispatch—Traffic Management Center Field Operational Test: Washington State Final Report* (SAIC 2006) examined the impact of direct data sharing between the Washington State Patrol dispatch and TMC software.

The Operation Test had three components: a Primary Alert that transferred data from the computer-aided dispatch system to the traffic management system for traveler information and Washington DOT maintenance/scene support purposes, a Response Support component that allowed DOT information (construction information, traffic data, or other events) to be automatically transferred to the dispatch system, and Secondary Alerts to provide data to non-State Patrol EMS responder dispatch systems. The Secondary Alert component was not implemented in this test because the prospective EMS partner was too small and had too focused a service mission to benefit from the system.

The system for passing data between the systems was developed and functioned according to design expectations. However, the authors noted several elements that reduced the expected impact of the system:

- The State Patrol and DOT personnel already had approved operational integration plans and had developed methods for communicating data. This made the additional system less significant than if they had not already been working closely together.
- The computer-aided dispatch system would not ingest data as originally planned. A separate web-based interface was required for the DOT data to be used. This additional interface interrupted the original workflow of the dispatchers.
- The operational geographic boundaries differed between the State Patrol and DOT, which resulted in gaps in information being transferred between systems.
- The traffic management software had significant latencies (up to 4 minutes) when importing data from the dispatch system.
- Dispatch system modifications and upgrade schedules limited the speed with which the traffic management system portion could be deployed.
- Dispatch and traffic management systems used different coordinate systems to define data locations. Translating between these can introduce errors.
- Different standards were used to encode the various data elements. For the data sharing to function, translation between them was necessary.
- Despite these limitations, it was noted that such integration could be particularly useful in rural areas, where latency tolerances (for dispatch to traffic management system transfers) could be longer and lower staffing levels could benefit from greater automation.

A number of states have also begun deploying integrated voice and data radio networks to enable communications across multiple agencies performing a variety of functions. For example, the South Dakota Interoperable Communications Plan (South Dakota Public Safety Communications Council 2007) describes the arrangement, management, and procedures for use of a statewide, interoperable digital radio system.

Agencies such as ambulance services, air ambulances, and hospital laboratories (for emergency and bioterrorism response) will have preprogrammed radios provided to them by the South Dakota Department of Health. Hospitals are expected to monitor the channel or “talk group” to which they have been assigned. Authorized users of the emergency response talk group include the following:

- Law enforcement (federal, state, or tribal)
- Fire departments
- Any licensed ambulance service (ground or air)
- Any hospital recognized by the Department of Health
- Any emergency management agency recognized by the Department of Public Safety
- Any state or local transportation agency
- Transit systems (subject to approval)
- National Weather Service offices
- Support agencies (such as Red Cross or Salvation Army and service agencies for critical infrastructure).

The report states that the high level of integration and interoperability incorporated into the design of the system is critical for states such as South Dakota, which are characterized by low population densities and long distances between facilities.

Many states have similar documents, although they differ in process, capabilities, and operational rules. The South Dakota study identified Arkansas, Idaho, Iowa, Kentucky, Minnesota, Nebraska, New Hampshire, South Carolina, Vermont, and Wyoming as having communications interoperability plans or systems in place for emergency responders (South Dakota Public Safety Communication Council 2007). Eight of these 10 states are included in the survey element of this synthesis study.

ITS and Transportation Safety: EMS Crash System Data Integration to Improve Traffic Crash Emergency Response and Treatment (Horan et al. 2009) conducted a case study examination of the state of real-time data integration across emergency response and transportation entities. Table 4 (Table 2.1 in the original document) summarizes the information technologies used at each stage of crash response.

These individual information systems exist as "silos" of data, which do not link records, even though they relate to the same crash patient transfer of record of care/discharge. Efforts to improve data sharing and crash response focus on crash identification and improved collaboration between EMS and trauma data systems. These efforts are outlined in the Strategic Highway Safety Plans (SHSP) prepared by individual states. Table 5 (Table 3.1 in the original document) presents a brief summary.

The study also conducted focus groups with representatives from the Minnesota Emergency Medical Services Regulatory Board, the Health Department (State Trauma System), Department of Transportation (ITS Program and Office of Traffic Safety), and Department of Public Safety (Traffic Safety). The group feedback included several important aspects of EMS data management:

- Information collection practices are not defined or enforced at the state level.
- Data reporting generally takes place after admission to a trauma center, so it is not available to physicians when the patient arrives.
- Communication infrastructure factors may prevent wireless transmission of patient data.
- The current consolidation of dispatch centers has created uncertainty around roles and responsibilities.
- Limited availability of staff time hinders data analysis.
- Financial concerns limit hospitals' willingness to share data that could reveal pricing structures.
- Data privacy policies hinder sharing of data between agencies.

In addition, a case study of the Mayo Clinic in Rochester, Minnesota, was completed to assess how data exchange could be enhanced through information technology (Horan et al. 2009). A series of three focus group sessions created a series of findings that were organized into three areas:

1. Operational Linkage Issues: Stored patient data (e.g., medical records) are not available to EMS personnel; data must be entered multiple times into different systems; "siloed" records do not allow for analysis of patient outcomes related to emergency response practices; lack of open standards makes system interoperability challenging.

TABLE 4

EMERGENCY RESPONSE PROCESS INTERVALS AND SAMPLE TECHNOLOGIES USED

Process Intervals	Example Information Technologies Used
Pre-incident preparation	Electronic Personal Health Record (PHR) for emergencies (the AAA card for personal health emergencies)
From "crash" to "notification"	911, E-911, AACN technology and integration (e.g., Mayday system)
From "notification" to "dispatch"	Computer-aided dispatch (CAD), traffic management systems, GPS + [Geographic Information System (GIS)], mobile data terminals (MDTs), decision support tools, 2-way radios, pagers, cell phones
From "dispatch" to "arrival on scene" (in-field care)	CAD, patient care record (PCR) systems, traffic management systems, GPS + GIS, MDTs, decision support tools, 2-way radios, pagers, cell phones, navigation systems
From "arrival on scene" to "departure to hospital/trauma center" (in-field care and transport)	PCR systems, decision support systems, telemedicine applications (remote care), wireless data communications, hospital availability/diversion systems
From "departure to hospital/trauma center" to "arrival to hospital/trauma center" [transport and handoff to hospital emergency department (ED)]	PCR systems, traffic management systems, GPS + GIS, navigation systems, hospital availability/diversion systems
From hospital "admission" to "discharge"	Hospital emergency department admissions/registry, trauma registry, electronic medical records, clinical information systems, electronic lab/radiology systems, clinical decision support
Post-incident evaluation	Crash Outcome Data Evaluation System (CODES), data warehouses, business intelligence, crash analysis reporting systems [e.g., Fatality Analysis Reporting System (FARS)], other reporting and analytics

Source: Horan et al. (2009), Table 2.1.

TABLE 5
COMPARISON OF SHSPS

SHSP EMS Related Descriptions	SHSP Described Efforts and Demonstrations
Minnesota Focus: Creation of a statewide system to reduce crash response times by improving patient to trauma ward routing practices	Improvement on ACN and 911 routing communications and development of rural intersection decision support technologies
Alabama Focus: Reducing the time from crash to care by ensuring that trauma patients are transported to an appropriate facility with resources to care for patient injuries	Provide crash location through advanced GPS technologies; make efforts toward statewide EMS quality and services coordination and increase consumer education on traffic safety. Improve electronic data and voice
Maryland Focus: Improving EMS across a range of technology, process, and program improvement	Improve electronic data and voice communications for emergency response and improve resource deployment for EMS response
California Focus: Reduce crash-related fatalities by at least 5% from 2004 levels through improvements in EMS system communications, response and safety education	Advance technologies for locating crash sites, improving EMS access routes, dispatching, decreasing response times and increasing overall EMS system resources and effectiveness
Utah Focus: Review of current systems in order to increase opportunities for crash data use	Plans to advance development of technologies to analyze, and distribute crash data in a timely manner across multiple agencies with goals of increasing quality assurance standards
Washington Focus: Continued efforts in developing Washington's EMS and Trauma Care System (EMSTC)	Improve communications between response agencies, implementation of dispatch protocols, statewide implementation of GPS technology and continued efforts in partnerships to improve data

Source: Horan et al. (2009), Table 3.1.

2. Organizational Linkage Issues: Need for system-wide, interorganizational approaches to integration; need for individuals to "self-check" performance; greater interaction across agencies would improve trust and cooperation; involvement of stakeholders (e.g., legislators, EMS agencies) is needed for improvements.

3. Governance Linkage Issues: Use contracts to enforce performance levels with partner agencies; use information sharing even when contracts to do so are not in place; seek opportunities with agencies such as the Department of Homeland Security; costs of personnel to implement/manage data systems can be prohibitive.

The authors propose that an Integrated Crash Trauma Network is needed to permit access to a broad range of medical and EMS data in a timely, uniform fashion, and recommend that their findings be validated and that a prototype software deployment be constructed to verify functionality and provide a base that can be improved through an iterative feedback process.

Table 6 summarizes the EMS information contained in SHSPs for the 14 focus states. (Note: The SHSP documents were found from FHWA website links, and may not be the most recent SHSP documents available.) The table summarizes the EMS objectives and EMS described strategies, and finds that the emphasis on EMS varies from state to state.

In a follow-up study, *ITS and Transportation Safety: EMS System Data Integration to Improve Traffic Crash Emergency Response and Treatment—Phases IV and V* (Schooley et al. 2012), the authors describe the second version of a software system called CrashHelp that uses a combination of mobile smartphone, multimedia, web server, and location-based technologies to enable information transfer between hospitals and responding paramedics. The study addresses a pilot test of the system in the Boise, Idaho, region.

The CrashHelp system has three main components:

1. A smartphone application for paramedics that can be used to communicate voice, video, pictures, and patient condition information.

2. A web application for emergency departments to review multimedia patient condition information, prepare for patient arrival, and communicate with medics as needed.

3. A backbone enterprise application server facilitating management and exchange of information between the first two components.

The 3-month pilot test included 20 ambulances across two agencies. Each ambulance was provided with a mobile smartphone, but they were not required to utilize the device at any point during the 3-month trial. Just under half of the paramedics used CrashHelp at least once with positive results.

The most frequent features utilized were camera, audio, texting, and notifications. The electronic map and video features were used less often. It was determined that CrashHelp benefited EMS incidents with higher severity levels and longer transport times as opposed to incidents with short transport times. This finding could be interpreted as the system being of more help to rural incidents where transport times are longer.

Potential system improvements resulting from the pilot test included addressing integration with existing EMS and hospital information systems, improving automatic notification of new CrashHelp records, a mobile application to be used on

TABLE 6
COMPARISON OF SHSPS FOR 14 FOCUS STATES

SHSP State	EMS Focus	SHSP EMS Objectives	SHSP Described Strategies
Arkansas	Yes	Improve access to crash sites and prehospital data collection systems, and develop statewide trauma system.	Install median gaps and acceleration/deceleration lanes, establish statewide trauma system, enhance data collection for traumatic injuries, and update systems to meet NEMSIS data elements.
Idaho	Yes	Quick and effective response to address the care of injured crash occupants and improve emergency communication.	Improve emergency scene management through training and funding to reduce rural transport times for patients.
Iowa	No		
Kansas	No		
Kentucky	Yes	Improve accessibility of EMS data through a statewide reporting system for EMS ambulance runs.	Use Section 408 funds to implement Kentucky Emergency Medical Services Information System.
Mississippi	Yes	Improve EMS response times in rural areas, and data linking between EMS, enforcement agencies, ambulance services, emergency departments and hospitals.	Increase funding of statewide trauma system, and improve access and integration of data.
Montana	Yes	Develop an effective and integrated EMS delivery system.	Provide comprehensive data collection and information system, and incorporate AACN.
Nebraska	Yes	Provide support for 44 designated trauma centers through registry and data information.	Implementation of statewide trauma registry, regulations requiring use of the NEMSIS patient reporting data set.
New Hampshire	No		
South Carolina	Yes	Expand EMS in rural areas where response time is greater than 10 minutes; expand communications; improve location coding for rural areas.	Implement NEMSIS data collection related to rural crash types; implement electronic data capture.
South Dakota	Yes	Web-based data collection software to increase contributions of response times and information. Mandate all hospitals to collect and report data on trauma patients within a trauma registry.	Working with [National EMSC Data Analysis Resource Center (NEDARC)] to examine data collection, with the potential to integrate crash, hospital, and ambulance service data. Work with Governor's EMS Advisory Committee on trauma registry legislation.
Vermont	No		
West Virginia	Yes	Reduce delays in discovery and rapid response, transport times, and limited resources. Establish data collection system with injury surveillance and EMS run data.	Ensure EMS access and coverage statewide, improve communication, develop electronic patient care record, and implement electronic EMS run form and rural inclusive trauma system/trauma registry.
Wyoming	No		

other devices, and the ability to enable hospital referrals. Additional challenges to be addressed include EMS picture-taking protocols, flexibility for new features, and paramedic versus emergency department expectations. A second phase of the pilot began in summer 2012 to address these challenges and further explore the impact on patient care within rural settings.

Record Linkages/Data Metrics: Retrospective Data Communications and Management

National Emergency Medical Services Information System (NEMSIS) is a collection of software tools and data repositories intended to facilitate the collection, aggregation, and dissemination of information related to emergency medical service response and outcomes. In "National Emergency Medical Services Information System (NEMSIS)" (Dawson 2006), the author outlines the five recommendations made by NHTSA in 1996 that formed the foundation of NEMSIS, including:

- Adoption of a uniform set of EMS data elements.
- Development of reliable, accurate mechanisms for collecting and transmitting data.
- Creation of comprehensive information systems to better assess patient outcomes and cost-effectiveness.
- Collaboration of EMS and other health care providers to develop integrated information systems.
- Development of a system to provide feedback to those who generate and input data.

NEMSIS funding began in 2001. The data set has been housed at NSHTA's National Center for Statistics and Analysis since 2005. The most recent version of the NEMSIS Data Dictionary is 3.2.6.

Plans to create integrated records systems continue to be studied. The authors of "Developing a Statewide Emergency Medical Services Database Linked to Hospital Outcomes: A Feasibility Study" (Newgard et al. 2011) developed a system of probabilistic record matching using LinkSolv, a statistical software package that can match records with incomplete data. Using patient care reports (run sheets) from EMS agencies, 60 NEMSIS data fields, and 23 additional fields needed to complete patient care record matching, the authors attempted to track care records from the initial crash reporting though patient discharge following care.

The report *The REACT Project: Rural Enhancement on Access and Care for Trauma* (Garrison et al. 2002) summarizes the results from the Rural Enhancement of Access and Care for Trauma (REACT) project performed by East Carolina University and the Eastern Carolina Injury Prevention Program. The REACT project itself was a follow-up to the 1992 NHTSA-sponsored Rural Preventable Mortality Study (RPMS). According to the RPMS, eastern North Carolina had an overall preventable mortality rate of 29%. The main objective of the REACT project was to decrease this rate of preventable deaths from injury in rural settings.

Intervention took place in the same region where the 1992 RPMS was conducted. This region, served by the trauma service of Pitt County Memorial Hospital, is composed of 29 counties in rural eastern North Carolina. The intervention phase of the REACT project had three components:

- Partnership with the Eastern Regional Trauma Coalition to develop trauma care guidelines for the treatment of trauma patients, which addressed the deficiencies identified in the 1992 RPMS study.
- Guideline-focused, in-depth training for emergency medical personnel in the region.
- Feedback to emergency medical personnel on their conformance to the guidelines.

The primary means of incorporating these three components into the existing trauma service was use of the Standards of care, Training, And Feedback (STAF) model. This model was directed toward prehospital and hospital emergency providers in the rural areas served.

Based on the intervention, there were two subsequent evaluation components:

- Assessment of the compliance with trauma care guidelines during the intervention phase.
- Determination of the preventable mortality rate for the region during the intervention year to determine if intervention had an impact.

As a result of this intervention, improvements were seen in both compliance and the preventable mortality rate. Compliance was measured over each quarter during the year and showed improvements from the first through fourth quarters. A comparison of the 1992 RPMS study and the 1998 REACT project show that preventable death rates were cut nearly in half.

- The REACT Project—1997/1998
  - Overall preventable death rate of 15%
  - 31% of cases had some aspect of inappropriate care.
- The RPMS—1992
  - Overall preventable death rate of 29%
  - 68% of cases had some aspect of inappropriate care.

Overall, implementation of the STAF model appeared to reduce the rate of preventable trauma deaths in rural areas, when the REACT Project is compared with the RPMS. This finding was also supported by other mortality studies conducted previously in both Michigan and Montana.

An overview report by NHTSA, *The Crash Outcome Data Evaluation System (CODES) and Applications to Improve Traffic Safety Decision-Making* (NHTSA 2010), provides insight into CODES, which is a part of its State Data Program. The basic concept of CODES is to link crash records to injury outcome records. These injury outcome records are obtained on scene or en route by EMS, by hospital personnel or at the time of death. Analysis includes both injured and noninjured people to reduce bias that may result by not including data from unexpected outcomes.

Application of CODES and other related programs result in four main objectives:

- *Objective 1: Identify Traffic Safety Problems*—Because CODES data are population-based, they can be used to help identify safety issues, including potentially significant crash outcomes. Some safety issues identified relate to teen driver crashes and passenger injuries, hospital charges and durations for motorcycle-related injuries, seat belt usage, and child injuries in passenger motor vehicles, among others.
- *Objective 2: Support Traffic Safety Decision-Makers*—Through CODES data, individuals in charge of making state and local traffic safety decisions can be better informed and educated. This helps prioritize traffic safety issues with other public health issues.
- *Objective 3: Support Traffic Safety Legislation*—Many traffic safety decision-makers are working toward legislation that can result in meaningful safety impacts. With CODES data, legislators are more aware of traffic safety issues in their state.
- *Objective 4: Educate the Public*—Educating the general public is critical because they are the motorists that make up the statistics in the CODES data. Properly educating the general public on traffic safety information and providing it through a convenient means may help to reduce crashes.

The CODES report provides a case example of a study completed in Alabama. The study "Does Increased EMS Pre-Hospital Time Affect Patient Mortality in Rural Motor Vehicle Crashes? A Statewide Analysis" was performed by the Center for the Study of Rural Vehicular Trauma. The report identifies a distinction between rural and urban fatalities, which was found by measuring EMS response, scene, and transport times. Average EMS prehospital times resulting in fatalities were 42.0 minutes for rural incidents and 24.8 minutes for urban incidents (Gonzalez et al. 2009).

Crash Detection, Locating, and Reporting

The crash-to-responder notification interval is an area that has been studied for its potential to reduce EMS response times. AACN systems use vehicle sensors (or manual triggering by occupants) to contact an external entity (generally a service provider) who can then assist the traveler or connect them with a PSAP. AACN, the successor to the Automatic Collision Notification (ACN) systems, incorporates vehicle sensor data and implements the Vehicular Emergency Data Set. These features are expected to enhance the usefulness of AACN over earlier ACN deployments, some of which are described here.

Crash Location Systems (CTC & Associates 2003), a synthesis report prepared in 2003 for the Wisconsin DOT, documented ACN system development and availability to that point. Historical highlights included the formation of the Multi-Jurisdictional Mayday (MJM) Project in 1995, which facilitated operational ACN tests in Colorado, Minnesota, New York, and Washington State. The MJM's active phase ended in 1998 with the completion of operational tests and publication of evaluation reports. In October 2000, the National Mayday Readiness Initiative completed a set of recommendations, which included:

- Updating training standards for call takers to properly receiving ACN information and defining a process for accreditation of ACN service providers
- Creating a directory of all public safety agencies in the United States
- Improving data sharing procedures for emergency response agencies
- Developing uniform and acceptable business practices for ACN service providers
- Continuing focus on developing/deploying CAN.

The Minnesota Mayday Field Operational Test had two goals: (1) develop solutions for routing incoming AACN notifications to appropriate responders, and (2) obtain and interpret vehicle data to determine characteristics of the crash (e.g., rollover, final vehicle position). It used General Motors' OnStar technology as its foundation and sought to minimize startup costs through use of existing infrastructure. Cases where crashes were so severe that the ACN hardware was disabled were identified as a place for additional research.

The first end-to-end trial of an AACN system was in Harris County, Texas. A partnership among the Greater Harris County 911 Network, Intrado Communications, Southwestern Bell, Veridiant Engineering, Plant Equipment, Inc., and Combix Corp. created a system that used GPS positioning and vehicle sensors to detect and relay crash data. Intrado functioned as the ACN service provider and routed calls as needed. The project demonstrated that all of the components for ACN could be successfully integrated and used as part of an existing E911 system.

In Germany, the Emergency Call Center (ECC) receives data from the vehicle following an automatic crash detection or manual activation. The ECC then identifies the appropriate responder based on crash location and characteristics and notifies the appropriate responder.

The use of software to interpret AACN data and provide responders with information about potential injuries is detailed in "Reducing Highway Deaths and Disabilities with Automatic Wireless Transmission of Serious Injury Probability Ratings from Crash Recorders to Emergency Medical Service Providers" (Champion and Augenstein 2003). The report outlines the time-related issues in rural crash responses and contrasts them to urban statistics. Table 7 (Table 2 in the original document) illustrates the time differences for each phase of crash response.

TABLE 7

AVERAGE ELAPSED TIMES IN FATAL CRASHES IN 1998 (MINUTES)

Time Intervals	Urban	% Unknown	Rural	% Unknown
1. Crash to EMS Notification	3.6	46	6.8	37
2. EMS Notification to Scene Arrival	6.3	47	11.4	35
3. Scene Arrival to Hospital Arrival	26.6	72	36.3	67
4. Crash to Hospital Arrival	35.5	71	51.8	68
5. Recommended Time for ED Resuscitation (No Data in FARS)	15		15	
Average Totals	51		67	

Source: Champion and Augenstein (2003), Table 2.

The study table noted the following points:

- These are U.S. average elapsed times that consist of shorter and longer times and vary greatly by state.
- Time intervals 2 & 3 do not include the elapsed time from crash to EMS Notification.
- Bolded times indicate the average elapsed times that exceed benchmarks of 1 minute for EMS notification, 10 minutes for EMS scene arrival, and 45 minutes for hospital arrival in fatal crashes.

The authors noted that increased times between a crash and notification of EMS personnel are associated with higher percentages of crash occupants who die at the scene of injury. They concluded that AACN notifications within 1 minute of a crash are technologically possible and economically feasible, potentially reducing response times by up to an average of 5.8 minutes.

In March 1997, NHTSA funded development of the URGENCY 1.0 software package. URGENCY used data from vehicle sensors to triage crashes and assign a severity indicator ranging from 0% to 100%. The authors state that the combination of AACN and URGENCY software will improve response times and occupant survival rates. Reductions in fatalities as high as 20% resulting from the use of AACN systems are believed to be possible. Other studies cited by the authors indicate reductions of up to 6%.

The authors conclude that it is both technologically possible and economically feasible to have EMS crash notification within 1 minute, EMS scene arrival within 10 minutes, and trauma center arrival within 45 minutes for many crashes. However, they do not make specific statements about rural crashes.

Telemedicine

The *Telemedicine Journal and e-Health* study “Telemedicine Reduces Discrepancies in Rural Trauma Care” (Amour et al. 2003) is one of the first attempts to put a quantitative metric on the benefits of telemedicine for rural trauma patients. The goal of this project was to measure the effectiveness of allowing specialized surgeons to consult with local physicians on how to treat rural trauma patients. It involved Fletcher Allen Health Care (the level 1 trauma center in Burlington, Vermont) and four rural hospitals. Surgeons from the trauma center were equipped with video and audio transmitters in their homes and at work so they could consult physicians at the rural hospitals. Some key aspects to the study:

- Clinical outcome measures were developed before the implementation.
- Evaluation questionnaires were designed for the patients and users of the telemedicine system.
- Multiple telemedicine sites were set up at the trauma center as well as a telemedicine site in each of the surgeons’ homes.

A telemedicine consult was instituted when the patient had a Glasgow Coma Score of less than or equal to 13, penetrating truncal trauma, respiratory distress, or amputation, or when the physician decided it was needed.

The outcome of the teletrauma consults was evaluated by two means: (1) comparing the patients of telemedicine and nontelemedicine with a standardized scoring system, namely the Injury Severity Score (ISS); and (2) interviews and questionnaires given to referring and consulting physicians on the effectiveness of the telemedicine treatment.

Forty-one trauma consultations were performed, with 49% consisting of motor vehicle crashes. Three of these consultations were deemed to be lifesaving in the post-surgery interview. However, this experiment did not find telemedicine to be statistically beneficial compared with patients who did not receive telemedicine.

Teletrauma patients had average adjusted ISS scores of 25.3 compared with the non-teletrauma patient score of 18. Teletrauma did not statistically decrease total time from injury to arrival at trauma center; however, the overall mean travel time was 34.8 minutes less ($p = 0.26$). Also, the length of stay of teletrauma patients was not significantly longer.

The lack of conclusive results may stem from the smaller number of telemedicine consults and the fact that patients who received telemedicine treatments had much more severe injuries. However, the surgeons who completed the questionnaires had a positive view of telemedicine. In 61% of the cases, they believed that telemedicine had improved patient care, and in 67% of the cases they believed that the recommendation could not have been made by telephone.

The Journal of TRAUMA® Injury, Infection, and Critical Care published a study on the effect of implementing telemedicine stations in Mississippi. The “Impact of Telemedicine upon Rural Trauma Care” (Duchesne et al. 2008) study equipped seven local hospitals in the state with remote controllable cameras providing access to an experienced surgeon at the University of Mississippi Medical Center. This trauma center receives an average 3,500 trauma patients a year, of which 60% are transfer patients. The data for the study were collected over a 5-year period, which included the 2.5 years before and after the telemedicine equipment was set up in the local hospitals. Data collected for this study included the mode of transportation; length of local hospital stay; and transfer time, or was the time between the initial report at the local hospital and the arrival at the trauma center.

The telemedicine system allowed the physician at the local hospital to request a consult or a “stat” from a trauma center surgeon. Requesting a consult would put the local physician and patient into a queue. However, if the patient required immediate assistance, a “stat” would be requested, which put the conference first in the queue.

A total of 351 trauma patients were presented to the local hospitals during the first half of the study and 463 during the second half. Of the 351 original patients, 100% were transferred to the trauma center, and of the 463 telemedicine patients, 11% were transferred to the trauma center and 1.1% were transferred to another local hospital. There was no significant difference in the mode of transportation used for transfer. The length of stay pre-telemedicine was 47 hours compared with 1.5 hours post-telemedicine. The transfer time (the time between the initial report at the local hospital and the arrival at the trauma center) for pre-telemedicine was 13 hours compared with 1.7 hours post-telemedicine.

The implementation of telemedicine significantly reduced the total transfer time and length of stay for trauma patients presented to local community hospitals in Mississippi. The decrease in these times is thought to come from the better understanding of the initial care, and through improved communication with the trauma center.

Air Medical Transport

This section focuses on the use of air medical transport (helicopter and fixed-wing aircraft) centered on performance (transport time) and cost-effectiveness measures.

Academic Emergency Medicine published a study on the effect of the lack of helicopter transport on the mortality rate of severely injured patients. "Injury Mortality Following the Loss of Air Medical Support for Rural Interhospital Transport" (Arthur et al. 2002) compared two regions, each consisting of four rural hospitals and one tertiary trauma center. The study compared the mortality rate of the two regions before and after the "test" region had discontinued the use of helicopter transport. The comparison data were collected from the 3 years before helicopter transport was discontinued in the test region and the 3 years after it was discontinued.

The patient data consisted of the ISS; level of neurologic function on the Alert, Voice, Pain, Unresponsive scale; and mortality up to 30 days after discharge from the tertiary trauma center.

- Over the 6-year test period, 38% of presenting patients from the control region and 20% of the presenting patients in the test region received inter-hospital transfer.
- The mortality rate of transferred patients was 26% after the loss of helicopter transport compared with 9% mortality during the same time in the control region, and 7% before the discontinuation.
- The mortality rate did not change in the control region between the two time periods.

Before the discontinuation, the two regions had transferred presenting patients 24% of the time for the test region and 25% for the control region. After, the test region transferred 15% and the control region transferred 51%. Before the discontinuation, the median transport times for the test and control regions were 2:07 (hr:min) and 2:15, respectively. After, transport times were 3:10 and 2:10, respectively. This study concluded that without the availability of air medical transport, the odds of death increased among severely injured patients in rural areas. Also, the lack of air medical transport increases transfer time between rural hospitals and trauma centers.

The "Helicopter Use in Rural Trauma" (Shepherd et al. 2008) study, published in *Emergency Medicine Australasia*, focuses on providing statistics for helicopter versus vehicle transport for rural trauma patients in the Australian outback. The study also provides insight to the effectiveness of an on-flight physician. The study data come from the documented activity of the Helicopter EMS (HEMS) in rural northwestern New South Wales.

Helicopter trauma incidents were found by reviewing the helicopter operator's activity log from January 2004 to November 2006. Response and scene times were estimated from engine hours in the helicopter's maintenance log. Ambulance travel times were estimated from GPS mapping by finding the most direct route from the Tamworth Rural Referral Hospital to the accident scene. Two hundred and twenty-two trauma missions were identified with the activity log, of which 171 had records with complete data for analysis. Eighty-seven of the 171 of the trauma injuries were vehicle-related, and 129 were taken to Tamworth Rural Referral Hospital. Table 8 (Table 3 in the original document) shows

TABLE 8
COMPARISON OF TIMES FOR TWO-WAY HELICOPTER JOURNEY AND ONE-WAY ROAD RETRIEVAL

Retrieval distance by road	No. of patients	Mode	Mean transit time in min (SEM)
<50 km	18 (10%)	Road	29.44 (2.22)
		Air	48.11 (5.81)
		$t = -3.00$, $P = 0.00$ (95% CI −31.31 to −6.02)	
50–100 km	41 (24%)	Road	56.34 (1.79)
		Air	62.63 (3.52)
		$t = -1.59$, $P = 0.12$ (95% CI −14.16 to 1.57)	
>100 km	112 (66%)	Road	141.21 (5.32)
		Air	93.16 (3.18)
		$t = 7.76$, $P = 0.00$ (95% CI 35.85 to 60.26)	

SEM, standard error of the mean.

Source: Shepherd et al. (2008), Table 3.

the mean transit time for helicopter and vehicle transport for different distances.

There was no significant difference between outcome of patients treated by the ambulance office and the outcome when a physician was on site. Because of this, the author suggests caution in mandating that a physician be on all helicopter missions, especially in areas with limited physician availability.

"When Is the Helicopter Faster? A Comparison of Helicopter and Ground Ambulance Transport Times" (Diaz et al. 2005) is a retrospective analysis and comparison of transport times for ground ambulances and helicopters. The authors differentiate between simultaneous and nonsimultaneous dispatch, which is when an ambulance and helicopter are directed to the scene immediately on receipt of a call versus when a responder arrives on scene by means of ground transport and then assesses whether to request helicopter response.

The analysis used data from Fresno and King counties in California over a 4-year period (1996–2000) for ground ambulances and a 3-year period (1997–2000) for helicopters. Distance for ground vehicles was determined from odometer readings recorded by ambulance crews. The response distances for helicopters were taken from on-board GPS receivers. To correct for roadway versus "straight line" miles flown by helicopters, a factor of 1.3 was applied to the odometer readings.

The analysis made use of 715 simultaneous and 360 nonsimultaneous helicopter dispatch records and compared them with 7,854 ambulance records to determine response times categorized by distance of transport. The authors conclude that for distances of greater than 10 miles from scene to care facility, simultaneous dispatched helicopters result in lower overall transport times. For nonsimultaneous dispatched helicopters, ground ambulances result in shorter average transport times for distances of less than 45 miles.

A number of notes are given to qualify the conclusions, including the following:

- It has not been definitively established that patients derive a benefit from air medical transport. Although some studies cited in the report indicated decreased patient mortality, this is only for the most severely injured patients.
- Air medical transport is substantially more expensive (by a factor of 5 to 10) than ground transport.
- Geography, roadway characteristics, availability of landing zones, and other factors unique to the study area may limit the ability to generalize findings to other areas.

"Cost Effectiveness Analysis of Helicopter EMS for Trauma Patients" (Gearhart et al. 1997) addressed the cost-effectiveness of air medical transport. The basis for comparison chosen by the authors was cost per life saved and cost per year of life, which was discounted to current dollars for the analysis.

Determination of additional lives saved used a probabilistic model based on Trauma Score—Injury Severity Score calculations. To ensure that calculated values agreed

TABLE 9
EFFECTIVENESS OF HELICOPTER EMS

Author (Year)	No. of Patients	No. of Expected Deaths	No. of Observed Deaths	Expected Mortality (*e*/*n*)	Standard Mortality Ratio (*o*/*e*)	Additional Lives per 100 Flights
Baxt (1987)*	574	36.4	30	0.063	0.82	1.1
Cameron (1993)	242	41.8	34	0.17	0.81	3.2
Schmidt (1992)*	407	57.0	42	0.14	0.74	3.7
Baxt (1985)	1,273	240.7	191	0.19	0.79	3.9
Hamman (1991)	259	32.0	20	0.12	0.63	4.6
Rhodes (1986)	130	28.6	22	0.22	0.77	5.1
Our study (1997)	604	90.3	50	0.15	0.55	6.7
Schwartz (1989)	168	36.7	25	0.22	0.68	7.0
Baxt (1983)	150	20.6	10	0.14	0.49	7.1
Campbell (1989)	168	50.0	31	0.3	0.62	11.3
Boyd (1989)	103	45.5	33	0.44	0.72	12.1

Source: Gearhart et al. (1997), Table 1.
*These studies report two separate cohorts, which are combined in this table.
Notes:

- Expected deaths (*e*) are calculated with TRISS analysis. Only the air cohort is used from studies including both air and ground cohorts.
- Additional lives per 100 flights are calculated as: (*e*/*n*)[1 - (*o*/*e*)]lO0.

with the range previously established in other studies, the authors reviewed research to compare their values with other estimates for additional lives saved per 100 flights. Table 9 (Table 1 in the original document) presents this comparison.

The authors completed a cost assessment based on data from a university-based hospital with a helicopter service. Costs included capital, operations, personnel, and overhead (e.g., insurance, administrative) elements. Using these data, the cost-effective measure (cost per life saved) for helicopter transport was estimated at $60,163 with a discounted cost (at 3%) of $2,454 per additional year of life. This figure measures favorably when compared with other medical intervention, such as the cost-effectiveness of prehospital paramedic system, which was $8,886 per additional year of life. The authors conclude that air medical transport of trauma patients has cost-effectiveness similar to other life-saving measures.

Apart from comparisons of transport methods, the efficacy of stabilization of rural trauma patients at Level III emergency departments before transport to Level I trauma centers was examined in "Stabilization of Rural Multiple-Trauma Patients at Level III Emergency Departments before Transfer to a Level I Regional Trauma Center" (Veenema and Rodewald 1994). The authors examined cases in Wayne County, New York. The study included two hospitals with Level III emergency departments. There was no double-physician coverage in either emergency department at any time, although both were staffed 24 hours a day. There was also no organized trauma protocol in use at either emergency department during the study period.

A total of 50 patients met the study criteria (Revised Trauma Score > 11, admitted to Level III emergency department and either died at Level III emergency department or were transferred to Level I emergency department). These cases were divided into three groups based on their time spent at the Level III emergency department before transfer to a Level I facility and assessed for unexpected outcomes when compared with model predictions for outcome based on trauma score. Neither the "short time" group (35 to 65 minutes at Level III emergency department) nor the "long time" group (173 to 415 minutes) showed any unexpected outcomes (survival or deaths). However the "middle" group had two unexpected survivors and one unexpected death. The authors conclude that stabilization at Level III emergency departments is viable as an alternative to long-distance EMS transport to regional trauma centers. However, they caution that small sample sizes and variability in Level III trauma protocol adherence should be taken into account.

"Helicopter EMS Transport Outcomes Literature: Annotated Review of Articles Published 2007–2011" (Brown et al. 2012) is a review article that presents the most important HEMS outcomes published between 2007 and 2011 as an evidence basis for HEMS use.

"Outcomes of Blunt Trauma Victims Transported by HEMS from Rural and Urban Scenes" (McCowan et al. 2007) compared mortality rates of HEMS-transported trauma patients of urban and rural scenes. The study location was Salt Lake City, Utah, and consisted of a review of records from two HEMS as well as three receiving Level I trauma centers. The review and comparison of urban and rural trauma patient outcomes concluded that there were no significant differences in mortality rates. Therefore, HEMS use for rural trauma patients eliminates the differences in mortality rates that are evident in urban and rural ground-transported trauma patients.

"Helicopter Emergency Medical Services (HEMS): Impact on On-scene Times" (Ringburg et al. 2007) compared prehospital on-scene times for patients treated by ground EMS with those treated by HEMS. A trauma registry study was performed using data from Rotterdam, the Netherlands. HEMS patients had longer average on-scene times than ground EMS by about 9 minutes, with a logistic regression suggesting a 20% higher chance of dying associated with a 10-minute increase in on-scene time. However, this effect was eliminated for HEMS attended patients. Despite the increase in on-scene time associated with HEMS use, HEMS are able to provide "golden hour" procedures at an earlier time than ground EMS, eliminating the adverse effects of on-scene times.

"Helicopter Use in Rural Trauma" (Shepherd et al. 2008) looked to determine whether any time savings were associated with HEMS use. Through a medical records review of multiple hospitals in New South Wales, it was determined that HEMS had a time savings advantage for distances greater than 100 km. Between 50 and 100 km, there were no time differences between ground EMS and HEMS, with ground EMS being significantly faster under 50 km. This study did not look at patient outcomes, only times-to-trauma centers.

"Helicopters and the Civilian Trauma System: National Utilization Patterns Demonstrate Improved Outcomes after Traumatic Injury" (Brown et al. 2010) focused on outcomes of injured patients for helicopter transport and ground transport using the National Trauma Databank. It concluded that helicopter transport increased the chance of survival and discharge to home after treatment. The authors also noted that helicopter transport is frequently used because of distance and geography rather than injury severity alone.

The "Helicopter EMS: Research Endpoints and Potential Benefits" (Thomas and Arthur 2012) article reviewed the potential benefits that HEMS provide to patients, EMS systems, and health care regions. A large amount of information in the review highlighted the importance of HEMS. Several key notes regarding HEMS are—

- Trauma surgeons support that HEMS response to trauma scenes provides life-saving care during the "golden hour" that is over and above care rendered by an Advanced Life Support (ALS) ground ambulance.
- HEMS can cover roughly the geographic area of seven ground ALS ambulances.
- It is well known that, particularly for rural locations, prolonged EMS response/transport time results in increased trauma mortality.
- HEMS crews' on-scene times are about 10 minutes longer than those for ground EMS crews.
- Similar scene-to-trauma center times for ground and HEMS transports were found in studies conducted in California and the Netherlands.
- A 2005 *Journal of the American Medical Association* study found that HEMS was the only mechanism by which 27% of the U.S. population had timely Level I or Level II trauma center access (within an hour of receipt of emergency call) (Branas 2005).
- The authors concluded that new helipad placements and additional HEMS programs "could be an important, and practical, means of extending trauma center access to populations that currently have none" (Baxt and Moody 1983, p. 2631).
- Preliminary analysis has suggested that HEMS is actually no more expensive than the multiple-ground-unit alternative.
- Data suggest that the early arrival of those able to provide ALS-level airway and hemodynamic support translates into improved overall outcome and better neurological function.
- While there is no "golden hour" for burn patients, epidemiologists and clinicians writing in a *Journal of the American Medical Association* study (Klein et al. 2009) point out that early care (in the first few hours) at a burn center improves outcome and that HEMS is the sole mechanism by which millions of Americans have access to burn center care within 2 hours of injury.

"Helicopter EMS: Outcomes Research, Cost-Effectiveness, & Triage" (Thomas et al. 2013) focuses greatly on HEMS, its potential benefits, and cost-effectiveness. It is difficult in general to study cost-effectiveness, but being that there are limited data regarding ground EMS to begin with, it only complicates things further. The main analysis in the study was of existing literature and study methodologies. According to the study, there are many benefits to HEMS when compared with ground EMS. Some takeaways and important comparisons are:

- Fatality rates per mile traveled are 0.4 per million air miles for HEMS compared with 1.7 per million ground miles traveled.
- Based on more than two decades of data, U.S. helicopter operations report less than one patient death per 100,000 missions.
- Early arrival of ALS, especially in rural or isolated areas, results in significant reduction of time to treatment.
- HEMS was estimated to be the only means of having timely (less than 1 hour) access to Level I or Level II trauma centers for 81.4 million Americans.

From a cost-effectiveness standpoint, a Norwegian study estimated the benefit-to-cost ratio of helicopter EMS to be 5.87:1. In addition comparisons of HEMS to ground EMS on the regional level have indicated that HEMS may be less expensive than deployment of a wide-ranging fleet of ground EMS vehicles. In comparing costs of HEMS to ground EMS:

- Per-patient costs from 1991 were $4,475 for HEMS and $2,811 for ground EMS.
- Cost per life-year saved has associated costs of $2,454 for HEMS and $8,886 for ground EMS.
- The study concluded that with both the benefits and the cost-effectiveness exhibited by HEMS that HEMS, in some form, is a must-have for many U.S. EMS regions.

Care Protocols and Procedures

The "Rural EMS En Route IV Insertion Improves IV Insertion Success Rates and EMS Scene Time" (Cummings et al. 2011) study, published in *The American Journal of Surgery*, compared the consequences of on-scene intravenous (IV) insertion with en-route IV insertion. IV insertion, which is a component of advanced life support, has been questioned because it can increase the on-scene time and therefore the crash-to-care time. The two metrics that were used to compare the two insertion methods were on-scene time and IV insertion success rate.

Study data were provided by the EMS provider in DeKalb County in rural Alabama. During 2007, none of the IV insertions performed by the EMS provider were done en route. In 2008, all of the IV insertions were attempted en route. The year of on-scene IV insertions produced these results:

- Three hundred and six trauma patients received IV insertion attempts on scene
- Seventy-six percent were vehicle crash occupants
- IV insertion success rate was 79%
- Average EMS on-scene time was 19.8 minutes.

The year of en route IV insertions produced these results:

- Three hundred and forty-one (239 motor vehicle crash) trauma patients received IV insertion attempts en route
- Seventy percent were vehicle crash occupants
- IV insertion success rate was 93%
- Average EMS on-scene time was 13.9 minutes.

On-scene time for the en route insertion is statistically less ($P < 0.001$), and successful insertion percentage for en route insertion is statistically more ($P < 0.05$).

The *Rural and Frontier EMS Agenda for the Future: A Service Chief's Guide to Creating Community Support of Excellence in EMS* guidebook (HRSA 2007) was published by the U.S. Department of Health and Human Services, Health Resources and Services Administration, and Office of Rural Health Policy. It was written to give recommendations to rural EMS agencies. It recommends a community assessment and planning effort, in which the EMS agency involves stakeholders from the community in the EMS planning process. The planning process should determine the EMS system that the community will support. Committed community stakeholders will thus provide for continued funding of the planned EMS.

The EMS should integrate with other "sectors" of the community including public safety, local health care systems, and public health. The integration across the entire range of care may deem the EMS eligible for "pay for performance" systems set up by federal agencies. The implementation of these "pay for performance" policies will reimburse organizations based on performance and the organization of all "sectors" will increase performance.

Another way to win these "pay for performance" reimbursements is to implement quality improvement systems they may someday be required by regulators. The quality improvement system depends on the agency's ability to gather and analyze data and to use the data to improve the system performance. Specific tasks that the guidebook recommends to achieve community support and a quality improvement system include the following:

- Locating data collection resources that may be available to the EMS.
- Building relationships with local schools to develop a data gathering system.
- Developing a "quality improvement" team to identify areas of potential improvement.

The National Association of State Emergency Medical Services Officials prepared a report, *Emergency Medical Services: Considerations for "Toward Zero Deaths: A National Strategy on Highway Safety"* (NASEMSO 2010), highlighting many strategies critical to improving EMS response and efficiency. According to the report, the fourth leading cause of nonfatal injuries treated in emergency departments nationally is trauma sustained by vehicle occupants during crashes, with more than 2.6 million patients seen in emergency departments each year. Through research, the CDC concluded that severely injured patients receiving care at a Level I trauma center had a 25% reduction in risk of death. The CDC also emphasizes access to trauma facilities as important to outcomes and provides mapping of 1-hour travel times to trauma care for the entire United States. However, there is no specific research cited to tie a 1-hour arrival time to patient outcomes.

In response to these statistics, the U.S.DOT has looked to implement a comprehensive EMS system nationwide through the Office of EMS under Traffic Injury Control in NHTSA. However, NHTSA does not directly oversee the approximately 15,000 local EMS agencies and 757,000 EMS personnel supported by states and territories. With the burden of reducing losses falling on EMS, public health, and trauma systems, there is no evidence indicating that all means of reducing losses in the post-crash phase have been exhausted. The report looks at several categories, highlighting key strategies to improve on those already existing.

- Detection and notification systems
- 911 access and capabilities
- EMS response and capacity
- On-scene medical care
- Patient transportation paradigms
- Definitive care: hospital and specialty care infrastructure
- EMS data, registries, and records linkage.

According to the report, it is possible to transmit data describing crash severity through existing telematics data definitions and transmission standards, but no standard data dictionary and .xml schema exists for use by telematics device manufacturers. AACN could utilize an urgency algorithm to determine the probability of severe injury through vehicle telematics data. AACN could also predict the need for vehicle extrication.

Enhanced 911 and Phase II compliance help dispatchers in locating a caller's address or location within 300 meters, which becomes crucial in motor vehicle crashes. Next-generation 911 would help 911 centers receive and process data other than audio (e.g., text messages, images, video).

The report discusses several standards and initiatives related to EMS response and capacity. These include the National EMS Scope of Practice Model and National EMS Education Standards, Vehicle Extrication Education and Competency Standards, Regionalization of Emergency Care, Integrated Ambulance-Based Safety Systems, IntelliDrive for Emergency Response Vehicles, and Evidence-based Emergency Vehicle Operations Standards. IntelliDrive for Emergency Response Vehicles currently only incorporates flashing lights and sirens as a "vehicle-to-human" means of communicating presence. "Vehicle-to-vehicle" interaction would assist drivers of other vehicles in the vicinity of ambulance in moving out of needed lanes. "Vehicle-to-infrastructure" interaction is in use, with an example being signal priority.

Topics discussed within the On-Scene Medical Care category include Field Triage Decision Scheme: The National

Trauma Triage Protocol and the National Unified Goal for Traffic Incident Management. Patient Transportation Paradigms summarizes Engineering and Design Standards for Ambulances, Helicopter EMS Utilization Criteria, and Ground Ambulance Access to Intelligent Transportation Systems (ITS) Infrastructure. EMS often are taken out of the range of their home 911 system, leaving them vulnerable to the absence of information about road hazards, closures, or changing weather conditions. Ground Ambulance Access to ITS Infrastructure could benefit the crew and patient's safety, route planning, and resource utilization.

The report includes statistics regarding hospital and specialty care infrastructure in relation to trauma systems and prehospital and interfacility telemedicine applications. Based on CDC maps, 8% of land and 57% of the population are within a 1-hour ambulance drive of a Level I or Level II trauma center. In contrast, 29% of land and 83% of the population are within a 1-hour trip by helicopter. This still leaves thousands of miles of roadways outside the range of Level I or Level II trauma centers regardless of access to helicopters.

The report also discusses EMS data, registries, and records linkage. NEMSIS is the nationally recognized EMS data repository that will be used to store EMS data from every state in the nation. Trauma registries may be used as reliable sources for severe injury data, in combination with records linkage, which makes other health care databases available.

The *Iowa DOT's "Golden Hour" Project: Recommendations for Reducing the Crash to Care Time* (SRF Consulting Group 2010) explored innovative uses of ITS to benefit the medical community in general, and emergency responders specifically. Recommendations for the DOT were developed from two primary sources for information: a literature search of sources relating to trauma care, and a series of interviews with experts working in trauma care in Iowa.

Traffic crash fatalities in the United States have historically been a rural phenomenon. Of the more than 40,000 annual traffic crash fatalities, more than 55% result from injuries incurred in rural crashes, even though only 20.8% of the population lives in rural areas (U.S. Census 2000). Of the 450 Iowa traffic fatalities in 2005, approximately 88% resulted from rural crashes (Iowa DOT). The three primary factors for the disproportionate number of rural traffic fatalities were roadway facility type, automobile speeds, and distance and time to a trauma care facility.

Several themes emerged from the interviews, which provided the basis for recommendations.

- *Theme 1: Improved Road Condition Information*. Nearly all formal and informal interviewees expressed a desire for additional road condition information, including weather, maintenance, and construction details. There was also interest in real-time snow maintenance data to indicate which roadways had been plowed and how much time had elapsed.
- *Theme 2: Communications Infrastructure*. The popularity of telemedicine and remote consultations is increasing, and as a result, some hospitals have been purchasing fiber-optic capacity from cable owners to minimize recurring costs and ensure connection quality. The value of remote video surveillance of high-accident rate rural intersections was highlighted by rural PSAP dispatchers, which would require a communications system to support the bandwidth needs of digital video.
- *Theme 3: Availability of Volunteers.* Those who expressed this concern saw it as the largest issue faced by rural emergency medical response.
- *Theme 4: Ambulance/Equipment Management.* Several interviewees expressed concerns about the maintenance and condition of vehicles and equipment, particularly in cases where there was no permanent maintenance or storage facility available for ambulances.

Several themes also emerged that, while not directly related to the core focus of the study, were seen as important to rural crash response, including the following:

- Differences in diagnostic capability, record-keeping conventions, and time pressures deprive the definitive care team of vital information.
- At-grade rail crossings can cause delays, and a system that automatically determines when a key intersection is blocked by a train along a projected response route could provide real-time notification to a dispatcher, who could then assess and relay information to a vehicle driver as needed.

The report recommended next steps in several "Action Areas" for follow-on work by the DOT in cooperation with EMS and trauma care providers:

- DOT operations representation on trauma board
- Expansion of travel data to local jurisdictions
- Improved user interface for emergency responders
- Sharing of real-time road maintenance data
- Coordination of communications infrastructure
- Certification program for DOT personnel as EMTs
- Co-location of emergency vehicles at state maintenance garages
- Real-time rail crossing status.

On-Scene and Transport Issues

The FHWA Office of Operations published a report titled *Best Practices in Traffic Incident Management* (Carson 2010), based in part on an international scanning tour sponsored by FHWA, AASHTO, and NCHRP. The scanning tour focused on Traffic Incident Management (TIM) planning and training, on-scene operations, technology use, and program management and administration. This report encompassed a wide variety of traffic incident management practices and pertains to all agencies that are involved in incident response, including first responders, law enforcement, tow and recovery vehicles, highway departments, and EMS. It is organized into four chapters and covers the following topics:

- Incident detection and verification
- Traveler information
- Incident response
- Scene management and traffic control
- Quick clearance and recovery.

The report cited the following factors that can lead to the slow or inaccurate detection of traffic incidents: inaccurate report of crash location, dispatch overload, and slow detection (particularly in rural areas). Some tools and strategies that can improve the accuracy and timeliness of incident detection include use of closed-circuit television cameras (CCTV), enhanced roadway reference markers, enhanced 911/automated positioning systems (i.e., next-generation 911), motorist call boxes, and AACN. It also indicated how the degree of emergency response can be either less or more than required, termed "under response" and "over response." Early and accurate assessment of the scene conditions is critical to establishing the appropriate resource needs. The use of CCTV to verify incident severity is cited as a solution.

The report identified various communication strategies that can enhance the emergency response process:

- Common mutual-aid frequency/channel
- Alternative communications devices
- Wireless information networks
- Mobile unified communications vehicle
- Standardized communications terminology/protocol.

Several technologies that can assist in timely and accurate emergency response were also identified. These include enhanced computer-aided dispatch systems and automatic vehicle location technologies that are used to locate, dispatch, and route emergency vehicles closest to the incident scene to minimize response time. In addition, "dual dispatch" is used in some areas; this involves dispatching emergency response vehicles from two different locations with the first to arrive providing aid and the second unit to return to base.

The report identified several areas that contribute to successful scene management. Those relating to this study include the use of emergency scene lighting, which can reduce the time EMS personnel spend on sight, and adherence to incident parking plans that provide for a quick in/out movement of EMS vehicles at the scene of the incident.

Underlying all of these issues is the value of engaging stakeholders in incident response planning. Bringing staff together from first responders, law enforcement, tow and recovery vehicles, highway departments, and EMS on a regular basis helps to establish common objectives and a better understanding of other agency needs and objectives. The stakeholder meetings also provide an opportunity for debriefing major incidents, conducting traffic incident management training, and developing traffic incident management guidelines. Training can be done at several different levels: training specific to traffic incident management within one's own agency or company, training aimed at increasing awareness of other responders' roles or existence, and training aimed at improving specific procedural operations. The report lists several training resources and communities of practice that are available. Another practice that fosters interagency cooperation is the creation of a joint emergency/traffic operations center to dispatch and monitor incidents through a common facility.

Training, or more specifically continued training, plays a critical role in innovation and improvement. Promoted in *National Traffic Incident Management Leadership & Innovation: Roadmap for Success* (Allwell et al. 2012), the second Strategic Highway Research Program (SHRP 2) has developed two products hoping to improve on-scene traffic incident management. These products, a multidisciplinary training course that provides a better understanding of quick clearance requirements and a 2-day train-the-trainer course facilitating use of the multidisciplinary training, intend to save time, money, and lives on the nation's highways. The multiagency National Traffic Incident Management Training Program hopes to strengthen traffic incident management programs in responder safety, quick clearance, and communications. Some of the topics covered in these courses include the following:

- Statistics, terminology, and standards
- Scene and responder safety
- Incident notification and response
- Arrival at the scene
- Initial size-up of the scene
- Command responsibility
- Traffic management
- Situational awareness.

EMS Service Challenges

A number of challenges in the provision of EMS are summarized in *Emergency Medical Services in Rural America* (Goodwin 2007) a report prepared for the National Conference of State Legislatures. The report organizes issues faced by rural EMS providers into three categories: recruitment/retention, reimbursement, and restructuring.

Recruitment/Retention

The current reliance on volunteers for rural EMS (80% of total workers) is cause for concern, given the demographic and economic realities facing rural America. Several states have initiated programs to improve the quality of care in rural areas, including the following:

- Financial incentives to attract and retain personnel.
- Financial assistance for items such as malpractice insurance.
- Use of EMS personnel in expanded health care roles (e.g., immunizations, primary care)
- Use technology (such as distance learning) to enhance training opportunities.

Reimbursement

Fixed costs in rural areas are comparable to urban centers, but patient volumes are much lower, resulting in higher per-patient costs. Potential solutions identified in the report include the following:

- Use providers to deliver preventive care, provide public health services, or work in emergency rooms. Currently, no mechanism exists for reimbursement; therefore, no incentive exists to use these providers most effectively and provide reimbursement for their services.
- Regionalize or consolidate administrative services to lower per-unit costs.
- Enhance community awareness of EMS structures and operations so that they can make informed decisions about the type of investment they want to make in their systems.
- Enhance access to capital. Although equipment and technology are costly, they are critical to improve quality. EMS leaders need to participate in federal and state dialogue and planning for health information technology.

Restructuring

EMS systems have developed independently and, as a result, are organized as "silos" of functionality, rather than an integrated system of service providers. The following strategies for establishing a more efficient and cohesive system were summarized in the report:

- Investigate cohesive and integrated systems, such as in Hawaii, where the state system is responsible for arranging personnel, facilities, and equipment in the prehospital setting. The system includes injury prevention and public education within the EMS system and combines data collection from EMS injuries, highway safety, and hospital discharge to help communities develop injury prevention programs.
- Institutional-level changes. Develop practice management guidelines and establish trauma centers staffed with appropriately trained personnel.

In response to motor coach incidents resulting in a high number of casualties and injuries, the NTSB made several recommendations including one to the Federal Interagency Committee on Emergency Medical Services in its report *Rural Highway Mass Casualty Guidelines* (NASEMSO 2011). These recommendations, based on the concept that emergency care systems may not be sufficiently prepared for motor coach crashes in rural areas, would result in the development of the following rural highway mass casualty guidelines:

Guideline 1: Evaluation of EMS System Readiness—The EMS Incident Response and Readiness Assessment (EIRRA) is designed to evaluate state, regional, and local EMS agencies' ability to respond to large emergencies. Highway maintenance and operations, law enforcement, fire/rescue, and emergency management personnel may also be evaluated by the EIRRA along with the EMS agencies. The EIRRA specifically evaluates these systems and agencies through benchmarks, indicators, and scoring. Table 10 shows an example of a scoring system for human resources availability:

Guideline 2: Prepare to Quantify Resources on a Geographic Basis—Another tool is the Model Inventory of Emergency Care Elements, which provides a visual display of resources and capacity by roadway segment. A future capability of this tool would be to provide highway officials, EMS officials, route planners, and the public with a regularly updated map showing segment capabilities for response. To determine the capability of each segment, six categories would be evaluated: personnel, transportation, communications, equipment/inventory, medical facilities, and other.

Guideline 3: Engage and Educate Partners—Recommendations for EMS officials to take leadership position in using EIRRA as well as the other tools and resources available on both the state and local levels. By sharing knowledge and critical information, improvements can be made to reduce the number of rural highway mass casualty incidents.

The 2011 CDC report *Guidelines for Field Triage of Injured Patients* describes revisions to the guidelines and reasoning for any changes. EMS providers must make decisions about the appropriate care and destination for injure patients on a daily basis. These guidelines are intended for use with individual injured patients and provide direction for EMS providers caring and transporting these patients. Published peer-reviewed research was the primary basis for any revisions made to the guidelines.

TABLE 10

SCORING CRITERIA FOR HUMAN RESOURCE AVAILABILITY

Indicator: 101. **Human Resource Availability**

Indicator	Scoring
Sub-Indicator: 101.1. **Patient Care Personnel (BLS)** - Basic Life Support levels of EMS personnel (first/emergency responders, Basic EMTs) are available in sufficient numbers throughout the area being evaluated.	0 **Not known** 1 There are **no** EMS personnel in the area (e.g. frontier areas). 2 There is a **minimal** number of BLS personnel in the area (primarily dispatch triggered first responders and a few Basic-EMTs). 3 There is **limited** availability of BLS personnel (a mix of Basic-EMT scheduled on-call/on duty and dispatch triggered first responders). 4 There are **substantial** numbers of BLS personnel (primarily Basic-EMT scheduled on-call /on duty with some dispatch triggered first responders). 5 There is **comprehensive** coverage of BLS personnel (full coverage of Basic-EMTs in the area).

Source: NASEMSO (2011).

Statistics regarding injuries and trauma centers across the United States show—

- Approximately 30 million injuries were serious enough to warrant visit to a hospital emergency department.
- Of these injured patients, 5.4 million (18%) were transferred by EMS personnel.
- National Study on the Costs and Outcomes of Trauma identified a 25% reduction in mortality for severely injured patients receiving care at a Level I trauma center.
- Only 28% of U.S. residents have access to specialized trauma centers within an hour by helicopter.

The report indicated that, ideally, patients with severe or life-threatening injuries would receive care at Level I or Level II trauma centers, with less serious injuries being handled by lower-level trauma centers or emergency departments. However, complexities of patient assessment in the field can affect triage decisions. Existing triage studies use retrospective data, trauma registry samples, single EMS agencies, and single trauma centers. Future research needs to include multiple sites, agencies, and centers to reduce bias and increase generalizability.

Field triage in rural settings could be better understood through further research in—

- Impact of geography on triage
- Issues regarding proximity to trauma centers
- Use of air medical services
- Using local hospitals for initial stabilization
- Secondary triage at nontrauma hospitals.

Improved field triage of injured patients can benefit EMS and trauma systems by reducing costs associated with trauma care, and increasing the care provided to the millions injured every year.

Planning and Innovation

NCHRP has assembled an extensive report to provide guidance for implementing AASHTO's SHSP. Strategies related to EMS improvements are covered in *NCHRP Report 500: Guidance for Implementation of AASHTO Strategic Highway Safety Plan, Volume 15: A Guide for Enhancing Rural Emergency Medical Services* (Torbic et al. 2005).

The document outlines the challenges facing rural EMS crash response, including:

- Importance of timely medical care in minimizing fatalities and the long-term effects of injury.
- Increased response times in rural areas, owing to delayed incident reporting and longer response times.
- Low volume of EMS calls in rural areas makes it difficult to develop adequate financial support, requiring the use of volunteers (65% to 75% of rural EMS personnel are volunteers).
- EMS personnel in rural areas often have less experience because of lower call volume.
- Growing recruitment and retention challenges of volunteer-based EMS agencies.
- Lack of comprehensive statewide trauma legislation in several states.

The report documented the rates of crashes per 100 million vehicle-miles traveled in rural areas as more than double that in urban areas (2.01 vs. 0.89). The guidance document then defines four objectives related to EMS enhancement:

- Integrate services to enhance emergency medical capabilities
- Provide or improve management and decision-making tools
- Provide better education opportunities for rural EMS
- Reduce time from injury to appropriate definitive care.

These objectives were then supported by 24 individual strategies, categorized as *tried* (implemented, but not fully evaluated), *experimental* (suggested and thought to be feasible), and *proven* (used in one or more locations and evaluated to be effective). A few of the relevant strategies are listed here. The abbreviations T, E, and P refer to the categories tried, experimental and proven:

- 20.1 A1—Establish programs with organizations to utilize nontraditional employees as EMS personnel (T)
- 20.1 A4—Integrate information systems and highway safety activities (T)
- 20.1 A6—Use mobile data technologies that are interoperable with hospital systems (T)
- 20.1 A7—Require all communication systems to be interoperable with surrounding and state jurisdictions (T)
- 20.1 C4—Require first care training for all public safety emergency response personnel, including law enforcement officers (T)
- 20.1 C6—Provide "bystander care" training programs targeting new drivers, rural residents, truck drivers, interstate commercial bus drivers, and motorcyclists (T)
- 20.1 C7—Provide EMS training programs in high schools in rural areas (T)
- 20.1 D1—Improve cellular telephone coverage in rural areas (T)
- 20.1 D2—Improve compliance of rural 911 centers with FCC wireless "Phase II" automatic location capability (T)
- 20.1 D3—Utilize GPS technology to improve response time (T)
- 20.1 D4—Integrate AVL and computer-aided navigation technologies into all CAD systems (T)
- 20.1 D5—Equip EMS vehicles with multiservice and/or satellite-capable telephones (T).

The report also recommended a number of related actions that, while not directly part of EMS operations, should be considered as part of an overall safety program. These included:

- Public information and education programs
- Enforcement of traffic laws
- Strategies directed at improving the safety management system
- Implementation of other strategies developed for other sections of the overall guidance for implementing SHSPs

To facilitate the pursuit of the objectives and assist with the implementation of specific strategies, the guidance document also defined an 11-step plan. This plan covered all aspects of implementation, from the initial definition of problem to performance assessment and transition from an implementation posture to a standard operating procedure.

CHAPTER THREE

SURVEY FINDINGS

GOALS

Survey questionnaires were administered for this synthesis study to collect data on emergency medical responses practices in rural areas, with a focus on practices that are identified as effective or innovative. The questionnaires targeted items provided in the scope of work, including:

- Patient outcome metrics
- Response and transport time metrics
- Cost-effectiveness metrics
- Identification of key partnerships
- Use of technology to enhance emergency response system performance and patient outcomes
- Innovative training and recruitment practices for emergency responders.

To achieve these goals, the survey asked about 14 states that have high fatality rates on rural roads: Arkansas, Idaho, Iowa, Kansas, Kentucky, Mississippi, Montana, Nebraska, New Hampshire, South Carolina, South Dakota, Vermont, West Virginia, and Wyoming.

SURVEY METHODOLOGY

Two surveys were prepared, one for the EMS community and another for the DOT community. Surveying these groups separately was done to provide a balanced view of the EMS response practices in these focus states.

Draft questionnaires were developed and distributed to the NCHRP liaison and Topic Panel members to solicit comments to either refine the content or questions. The final questionnaires balanced the need to acquire complete and accurate information with the need to make the survey process as efficient and unobtrusive as possible for respondents. Appendix A presents the final EMS and DOT questionnaires.

The survey questionnaires were then adapted into an online survey instrument, which was evaluated by Topic Panel members. Comments were incorporated into the final survey and it was then made "live." Each contact provided by the panel was sent an e-mail introducing the survey, describing its purpose, and providing instructions for completion. Each state's EMS director was instructed to forward the survey to appropriate staff for completion as necessary. The DOT survey was sent to representatives that serve on AASHTO's Standing Committee on Highway Traffic Safety.

The surveys were distributed on June 21, 2012, with a 3-week deadline to have them completed (July 13, 2012). After this period, follow-up contacts were made, first by e-mail and then by telephone, to secure 100% participation. The survey results were then extracted and organized for presentation. Responses were analyzed for similarities between responses and correlations in data, as well as for "outlier" information that may be useful for identifying novel or innovated practices.

EMERGENCY MEDICAL SERVICES SURVEY—SUMMARIZED RESULTS

Surveys were constructed from groups of questions in several topic areas to tie responses together conceptually for respondents. An overview of responses in each area is presented here.

Record Linkages and Data Metrics

All respondents replied that they collected data on EMS crash response times, patient destinations, and transport times. Additionally, 75% or more also collected data for injury severity, interfacility patient transfers, and the type of responder (e.g., law enforcement, rescue) Only two respondents indicated that they collected any data for patient outcomes, and no respondents collected information related to costs, charges billed or collected, or agency compensation.

There are a few indications that data were linked to other record systems. Six agencies responded to this question, with three indicating some link to hospital record systems and one to driver's license data. From these responses, it appears that scant data are available for patient outcomes, and virtually no cost data are available to assess cost-effectiveness or compensation for services.

Dispatching

Five of 13 respondents indicated that rural-crash specific programs existed to improve PSAP coordination and function. One of the positive responses indicated that a data-sharing project existed as part of the Highway Safety Program, and one reported that an AACN pilot program was in place.

All respondents reported that dispatchers will guide emergency vehicles to a crash scene if needed, and 92% indicated that paper maps were commonly used. Agency-approved GPS devices or personal GPS devices (including smartphones) were used by 75% and 50% of respondents, respectively.

Literature search information indicates that, if properly deployed and staff adequately trained, GPS guidance can reduce the time needed for responders to reach rural crash scenes. Further deployments for those not currently using the technology could be explored as a way to reduce travel times.

Of the 12 respondents who answered, 7 reported that there was a state- or regional-level organization that worked toward improving PSAP functions. The organizations were listed as primarily public safety, emergency management or a communications interoperability board.

With crash detection and responder dispatch representing a significant portion of total crash-to-care time, a coordinated effort to improve dispatching functions could yield significant benefits for patient outcome. Implementation of a coordinated program or the addition of PSAP-related function planning to an existing agency (as in those respondents who indicated that these efforts were organized by a state public safety department) could provide the framework for deployment of AACN systems and improve communications between facilities.

Nine of 13 responses indicated that there were no active efforts by their agency to reduce rural crash response times. Of those who answered that there were efforts under way, the focus was on expediting dispatch and improving guidance. Crash notification and locating were identified as having the greatest effect on response times.

These responses compliment the results obtained in the Dispatch Function section of the survey and agree with information found during the literature search. AACN and GPS systems have been shown to improve rural crash response times, but are not commonly in use.

Telemedicine

Six of 13 responses indicated that their agency used some form of telemedicine or telepresence technology, which was used primarily by emergency department or other hospital-based staff. Only three respondents said that the technology was used by emergency responders on-scene or en-route.

The benefits of medical expertise at the crash site, and conversely the ability for hospital staff to review multimedia information related to a crash incident, could be significantly enhanced by wider use of mobile telemedicine technologies. The majority (80%) of telemedicine applications primarily involved transmitting biometric data, suggesting further opportunities for integrating additional media types (e.g., live or recorded video) into the portfolio of communication tools.

A limiting factor for field or mobile telemedicine is the availability of a satisfactory communications network. The majority of those responding said that the cellular data network is the primary method of moving telemedicine data, which implies that the coverage of that network will be a driving factor in the availability of telemedicine tools on-scene.

Care Protocols and Procedures

Approximately half of all respondents indicated that uniform protocols and procedures were mandated in their state, with roughly one-third of respondents stating that these were uniform for all jurisdictions. Seven of 13 respondents indicated the present of an active program to evaluate protocols. The majority of those indicating an evaluation program said that it focused on patient treatment (stabilization and triage procedures), with an additional four replying that responder destination routing was being evaluated.

Standard protocols and procedures can simplify training and allow training resources to be pooled, as there is only a single set to be taught. The ability to recruit, retain, and train EMS personnel may be enhanced by standardizing the materials needed for study.

Air Medical Transport

All respondents indicated their agencies used air transport, and all reported that it was used to convey patients from a crash scene to a trauma center or an emergency department to a trauma center (interfacility transfer). In all cases, on-scene personnel (scene commander or medical personnel) are able to cancel requests for air transport, with a smaller number (41%) stating that dispatchers could also cancel transport requests. Paramedics or flight nurses were reported to be on-board personnel for all responses, with an additional response indicating that an inhalation therapist would be present.

Only two responses indicated that any evaluations of the effectiveness of air transport had been conducted. Examination of the on-board staffing, request/cancellation protocols, destination choices, and comparisons to wheeled transport may be able to provide insight into ways to improve the efficiency of air transport and patient outcomes. Weather conditions may also limit the availability of air transport, and the relationships of weather factors to crashes, air transport, and patient outcomes do not appear to have been investigated.

Equipment and Preparation

Only half of respondents reported that there was a standard checklist to ensure equipment availability and conditions prior to departure to a crash scene. In addition, only one-third said they were able to quickly check road conditions before departure, and 86% indicated that they depended on voice communications to a dispatcher to check conditions. More than 50% of respondents indicated that vehicle and equipment condition had delayed departures, thereby increasing response times.

The lack of quickly accessible information about roadway and equipment conditions appears to have adversely affected response times. Communicating roadway conditions effectively may require the development of a responder-specific "no-touch" interface that shows surface and construction conditions without requiring direct interaction. A standardized program to verify that equipment is present and in working order may also improve response times.

Recruiting, Retention, and Training

Three-quarters of EMS personnel are volunteer or part-time paid employees, primarily recruited through advertising in local publications or word-of-mouth. Nearly all (92%) indicated that there were no incentive programs in place to recruit or encourage training of employees in other agencies (such as highway operations staff). Staffing levels have also been identified as adversely affecting response times by 75% of respondents.

The ability to attract, train, and retain staff appears to be a major concern for emergency response. Partnering opportunities and incentives to increase staffing levels, as well as responder proficiency, could be investigated.

Planning and Innovation

All respondents reported one or more active partnerships to improve crash response. Eleven of 12 replied that they currently worked with a state DOT, with more than half also reporting partnerships with hospitals or other agencies. Only two of those surveyed indicated that they worked with PSAPs to improve response.

A variety of innovative approaches toward improving crash response were reported; however, only recruiting and triage/responder routing had more than five respondents that indicated the presence of an active program. The issues reported in previous sections imply that there are additional opportunities for innovative approaches beyond those currently in place.

Summary

From the EMS agency responses, several areas for future action emerged as potential avenues to improve rural crash response:

- Improved data collection (specifically cost, agency charges, and patient outcomes) to evaluate cost-effectiveness of procedures.
- Development and integration of AACN into dispatch and routing functions.
- Cooperative programs to share best practices for PSAP functions.
- Exploration of partnerships with cellular providers or other creative solutions to enhance high-bandwidth data connection that can enable on-scene and mobile telemedicine.
- Creation of a set of standards for GPS guidance quality and procedures for their use to maximize their benefit.
- Active evaluation of air transport on patient outcomes.
- Development of roadway information systems with interfaces optimized for the EMS responder.
- Creation of standardized equipment checklists and processes to ensure that equipment issues do not delay departures.
- Creation of creative incentives and recruiting tools to improve the availability and proficiency of EMS staff.
- Coordination of innovative efforts to improve crash response that share resources and disseminate lessons learned.

DEPARTMENT OF TRANSPORTATION SURVEY—SUMMARIZED RESULTS

The DOT survey collected data on emergency medical responses in rural areas, focusing on practices that are identified as effective or innovative. This survey was distributed to members of the AASHTO Highway Traffic Safety Subcommittee on Safety Management and forms the basis for a series of follow-up interviews to collect more detailed data on specific approaches or study results.

As with EMS agencies, surveys were constructed from groups of questions in several topic areas. An overview of responses in each area is presented here.

Record Linkages and Data Metrics

All of the responding DOTs collect data on the number and causes of rural crashes, with 13 of 14 also collecting fatality rates. However, few collect any information on the medical response aspects of a crash (no more than 2 of 14). This indicates an opportunity to integrate data from the DOTs' crash-related data with EMS patient and response data.

Interagency Cooperation and Coordination

In general, maintenance and emergency response dispatching functions are not co-located (10 of 13 responses). A greater number (9 of 14) have communications systems that are able to interoperate with emergency response or use a cell phone to coordinate (50%).

Emergency response and maintenance dispatch functions have been fully integrated (facility, communications, and dispatch software) in several locations. These could be examined for potential applicability to other locations and the benefits of such a deployment quantified.

Road Condition Reporting

Thirteen of 14 respondents indicated that they provide real-time roadway condition information, usually accessible through a 511 telephone number or a web-based information service. Smaller numbers used dedicated mobile smartphone applications, Twitter social media applications, radio broadcasts.

With only one-third of EMS personnel indicating that they were easily able to check roadway conditions, exploration of novel methods of delivering roadway condition information beyond telephone and web-based systems may be beneficial.

Planning and Innovation

Nine of 14 (64%) responded that their department participated in efforts to improve rural crash response, and the same percentage also indicated that their staff regularly assists with response. For those that do, the most common activities were traffic control and repairs of traffic control devices and bridges. A small number (3 of 14) also assisted with management of the crash site.

Respondents did not specify the site management functions. Further investigation may reveal functions beyond traffic control and facility maintenance suitable for transportation staffs to undertake.

FHWA *Traffic Incident Management Handbook* guidance and the strategies defined in the National Unified Goal for incident management were implemented by 8 of 13 respondents. All departments have active programs to improve their roadway condition data, with the majority (57%) engaged in vehicle telematics projects (e.g., AVL, signal pre-emption). Smaller numbers have ongoing projects involving AACN/severity determination, on-scene practices, staffing or funding, and data integration with EMS records.

These efforts compliment many of the activities described in the EMS survey as active projects, particularly the AACN and AVL/guidance aspects. Opportunities for combined efforts could be investigated.

Summary

DOTs are active in data collection and emergency response, but appear to conduct activities within a narrow range of disciplines. Opportunities appear to exist to combine efforts with EMS agencies on a larger scale than is currently practiced. Specific areas that warrant additional investigation include:

- Integration of crash data with EMS and hospital record systems.
- Improved roadway and construction information delivery interfaces for EMS applications.
- Tighter integration of dispatch functions and sharing of communications resources.
- Cooperation on automated crash notification and route guidance systems.

CHAPTER FOUR

CASE EXAMPLES

SELECTION OF RESPONDENTS

Five states were selected for follow-up informational interviews in order to capture a more in-depth understanding of rural EMS practices that are identified as effective or innovative. Representatives of both the EMS and DOT communities in each state were interviewed in order to capture each agency's perspective on EMS. The following criteria were used to select these states:

- Notable successes as reported by the agencies
- Unusually extensive data collection efforts, record linkage capabilities, or collection mechanisms
- Current or planned innovative technology deployments
- Geographic diversity
- Variety in the types of practices utilized
- Specific requests to provide more information by the respondent.

INTERVIEW METHOD

The survey respondent for the relevant agency was contacted by phone and email in order to schedule an interview time. The EMS interviews were conducted first, followed by DOT interviews. The interviews were structured to address the unique conditions and efforts under way in each state. An interview guide was developed to guide the interview process, one version for EMS interview and another for DOT interviews. These interview guides were distributed in advance of the scheduled interview and are provided in Appendices C and D.

EMERGENCY MEDICAL SERVICES INTERVIEW REVIEW AND SUMMARIZATION

The following five states were selected for interview and expressed a willingness to participate in a follow-up during the initial survey.

- Arkansas: Interview was conducted with the state EMS section chief with the Arkansas Department of Health.
- Idaho: Interview was conducted with the EMS communications manager for the Idaho State EMS Communications Center (StateComm). Also participating was a StateComm communication supervisor.
- Nebraska: Interview was conducted with representatives of the Nebraska Department of Health and Human Services, the EMS program administrator, the EMS program coordinator, and the EMS program training coordinator.
- Vermont: Interview was conducted with the EMS deputy director, an employee of the Vermont Department of Health, Office of Public Health Preparedness and EMS.
- West Virginia: Interview was conducted with the director of the Division of Trauma, Designation and Categorization; part of the West Virginia Department of Health and Human Resources, Bureau of Public Health, Office of Emergency Services.

EMS interview findings are summarized into 1 of 12 topic areas:

- Record linkages/data metrics
- Crash detection/locating/reporting
- Dispatching
- Equipment and preparation
- On-scene and transport issues
- Air medical transport
- Telemedicine
- Recruiting, retention, and training
- Tribal EMS
- Interagency cooperation and coordination
- Planning and innovation
- Other.

Record Linkages and Data Metrics

Nebraska

An initiative to expand electronic patient data records is under way. Record linkages to the trauma registry will be used to track patient outcomes. Interviewees said that data accuracy needs to be improved in cooperation with the trauma centers, and that more emphasis is needed on data reporting, especially from volunteer EMS.

The Nebraska Physician Medical Director and the Nebraska Statewide Trauma Data Committee are working on performance metrics and may have some findings to share. The trauma registry is another data source.

Arkansas

Arkansas recently began using trauma triage guidelines for ECS. These guidelines require the use of a centralized call center, referred to as “Trauma Call,” for every trauma-related response. EMS staff contacts the call center to provide information of injury severity and then receive direction on which trauma center to take the patient to. The system uses a “trauma dashboard” application to balance patient loads across the state on an hourly basis. Treatment recommendations can also be obtained from the call center, but most EMS providers utilize their local emergency department for this type of information. The call center is run by the Arkansas Trauma Communication Center. A database is available that tracks a number of variables, including time of arrival on scene, time of departure, prehospital transport time, interfacility transport time, and time of day that call center was contacted. This system also supports patient tracking—a patient is given an identification (ID) bracelet by EMS, with an ID number that tracks the patient from emergency care through to follow-up care, including rehabilitation. This database is linked to trauma registry data. Efforts are ongoing to link with hospital data systems.

Vermont

Vermont is in the process of implementing a statewide electronic Patient Care Report (PCR) system. The system is called the Statewide Incident Reporting Network; Image Trend is the vendor. On January 1, 2013, all transporting EMS will be required to enter data into the system. EMS staff will likely enter data upon arrival at the hospital. The PCR data will be linked to hospital data in order to track patient outcomes. The PCR data will also be linked to crash data through collaboration with the Highway Safety Office. There is a vision to deploy a statewide trauma registry, which will also be linked to this database. Performance metrics will be available from this system.

Idaho

Idaho is piloting a “CrashHelp” system that is currently deployed with two EMS agencies in the state. The system uses a mobile data platform deployed in EMS response vehicles to improve patient outcomes. The system provides a mechanism to communicate patient status quickly and efficiently between the hospital staff and response staff who are on the scene of a crash and during transport. The system is valuable in rural areas where cell phone coverage may be limited. In these cases, the flow of information can be done more quickly and efficiently than is possible by voice.

West Virginia

The Our Advanced Solutions with Integrated Systems (OASIS) Project is a statewide collaborative effort to bring to together crash, EMS, and trauma data. One of the project’s objectives is to quantify aspects of the crash care process and identify solutions that can improve patient outcomes. Potential improvements include reduction in response times, such as through better geographic positioning of resources. One limitation of the trauma registry is that it only includes serious injuries. The West Virginia DOT is a partner in this effort.

Crash Detection, Locating, and Reporting

Nebraska

CCTVs are deployed along key roadways where they can be used to monitor crash scenes and assist with providing appropriate crash response. The DOT is working on improving highway condition monitoring so that advisory information, such as the presence of black ice, can be provided to the public. Communication between agencies is improving, but still has a ways to go.

Some ambulance crews are able to pull up the crash location and current road condition information through their on-board devices. The technology is there, getting it implemented is the challenge. Additional mobile computer deployments will help. The Nebraska Department of Roads (NDOR) also has road data and live CCTV images posted on the 511 website, again trying to get ambulance and law enforcement to use the technology on their own. Dispatch helps EMS to be aware of construction zones, weather issues, and the like by monitoring the 511 website. EMS personnel can also check weather conditions before departing. Mobile networks are being improved throughout the state to improve communications for these applications.

OnStar calls, cell phone calls, and E911 have all proven helpful in providing dispatch with the location of crashes. OnStar calls are not frequent, but have helped save lives when they do come in.

There is a push under way in Nebraska to establish addresses for all rural areas of the state. This addressing effort is developing roadway numbering conventions and assigning address numbers for all rural residents. The addressing scheme will benefit emergency responders by providing a consistent way of entering location information into on-board GPS devices. Some emergency responders are still asking dispatch for directions while en route. The next challenge is getting the residents to use the new addressing scheme when reporting an incident.

Arkansas

Approximately 10% of the EMS service providers have in-vehicle computer systems that provide crash location information. Other service providers have used GPS or smartphone applications to aid in navigation, but a study conducted by Little Rock Metro EMS found that a 2- to

4-minute delay was associated with using these devices. The study found that delays were caused by the devices being faulty or difficult to operate. The use of these devices is currently banned, with an emphasis placed instead on the use of paper maps and improved familiarity with the service area. Dispatcher-provided EMS routing is available in some of the larger EMS service areas, but in rural areas the dispatchers provide only a description of the crash location.

The DOT maintains a 511 website that includes road closure information. Weather-related events are primarily monitored through phone conversations with State Patrol or sheriff offices. Some EMS staff has commented that the information on 511 is not updated frequently enough for use during an emergency.

E911 has proven to be an effective tool in determining crash location. The respondent was not familiar with any AACN efforts in Arkansas, but will look into it and provide any information found.

Vermont

E911 is utilized by PSAPs throughout the state. The PSAP centers are regionally based and have a fairly uniform operation. However, the EMS dispatch layer functions independently from location to location. There is variation in who these dispatchers are, who they dispatch to and the use of third parties for dispatching. EMS may be dispatched by police departments, fire departments, sheriff departments or multi-jurisdictional entities, depending on the area.

The state EMS office is currently working to improve linkages to PSAPs, local EMS dispatch entities and the 911 Board. They are in the process of obtaining a better understanding of the interrelationship of these functions. Emergency Medical Dispatch (EMD) services are not provided by PSAPs or other dispatchers.

Respondent was not aware of any substantial issues with vehicle or equipment preparedness. New England weather can pose challenges; so many EMS vehicles are four-wheel drive and have snow/ice chains available for use.

Idaho

StateComm has initiated a "Condition Acquisition and Reporting System (CARS) May Day" project in collaboration with ITD, the University of Miami, Castle Rock Consultants, OnStar, and the CDC. The system pulls data from OnStar-equipped vehicles that is generated when a motor vehicle crash occurs (OnStar is a proprietary AACN system available through General Motors). These data include vehicle location, change in velocity, air bag deployment status, seat belt status, and occurrence of a roll over event. The system then applies an algorithm to the data to estimate the severity of injury to the passengers and generates recommended emergency responses. Possible recommendations include the need for: air medical transport, advanced life support units, extrication equipment, and early hospital notification. The system went live in early summer 2012, but will operate in "shadow" mode while the algorithm's performance is evaluated against actual crash outcomes as obtained from the Trauma Registry. The evaluation period is expected to take a couple of years or more because only two or three crashes per month occur with OnStar-equipped vehicles. When the project stakeholders are comfortable with the automated emergency response recommendations, the system will be made live and the recommendations automatically provided directly to the appropriate PSAP for them to implement. The system interface includes an online map of the crash location. Idaho is the first state to deploy this system. The system is targeted at rural areas where crash response times are the most critical. The system is planned to be expanded to include AACN systems available from other motor vehicle companies.

Dispatching

Nebraska

In most portions of Nebraska 911 calls are automatically routed to the appropriate Public Safety Answering Point (PSAP). However in some larger urban areas, calls come into one dispatch center and then need to be routed to the appropriate local PSAP. This can result in some dispatch centers becoming overwhelmed in emergency situations.

The panhandle region of Nebraska was identified as an effective program for reducing dispatch and response times. The trauma unit at Region West Medical Center received a grant to deploy GPS in EMS, fire department, and law enforcement vehicles. The GPS system is integrated with dispatch operations and with air medical transport operations.

Two dispatch centers in the 17 county areas are EMD certified, which allows for some medical advice to be provided by dispatchers. Some EMS crews have been using GPS over the past 6 months to assist in routing. The use of GPS has proven effective at estimating the time of arrival. GPS was found to be more effective when travel times are longer. Gage County has implemented an AVL system in ambulances, allowing dispatchers to track their location. However, some areas of the county are not able to afford the cost of this device.

Arkansas

Arkansas's statewide EMS communication is provided by the Arkansas Wireless Information Network (AWIN) system. Every EMS vehicle has an AWIN radio that is used for placing calls to the statewide trauma call center and for mass casualty coordination (as needed). Communication to other agencies, such as DOT or state patrol, is relayed through the dispatch center.

Equipment and Preparation

Nebraska

Vehicle readiness has not been an issue in EMS response in Nebraska. An occasional ambulance has had to be jumped or has not started, but no issues are noteworthy. EMS are prepared for these possibilities through mutual aid agreements, and regular maintenance is performed on vehicles to try to minimize problems. No hard data are available because the crash record database does not track maintenance/operations issues affecting EMS response vehicles.

West Virginia

The EMS community has vehicle inspection criteria that are followed to minimize issues with mechanical/maintenance issues that may affect response times.

On-Scene and Transport Issues

Nebraska

The EMS group is working with the fire department to look for ways to reduce the amount of equipment sent to the scene of an accident. Unneeded equipment at the scene may result in traffic delays and secondary crashes. When equipment is sent to a scene, but is not needed, it is then not available for dispatch to other incidents. A better approach is to wait and see what is needed by responders.

A greater emphasis is being placed on obtaining the Glasgow Coma Score (GCS) by EMS personnel at the scene in order to better track patient conditions.

A recent review of more than 500 EMS runs identified what appears to be too much time spent at the crash scene. The cause of this time is currently being investigated further.

State trauma centers understand the critical role that EMS plays in improving patient outcomes, and the two communities communicate well and work well together. This EMS/trauma center collaboration has improved noncrash incidents, such as center-to-center transfer, responses to nursing homes, and the like. However, getting patients from a smaller hospital to a higher level of care in a timely fashion is an area that needs more focus because transfer has a big impact on patient outcome. The availability of a properly equipped ambulance for interfacility transport is critical.

Arkansas

Crash data are tracked by EMS service area on a statewide basis. The data are analyzed in various ways, including an assessment of whether on-scene times are longer than average in any particular service area. Opportunities to improve these times are then identified.

Vermont

Some EMS dispatchers will prompt EMS staff after they have been on the scene 10 minutes as a reminder to minimize on-scene time.

West Virginia

Statewide protocols are in place to address on-scene activities. These protocols emphasize steps that can be taken to minimize the time EMS personnel spend at the scene of a crash. The following web address was provided for more information: www.wvoems.org. A review of this website found several documents that detail on-scene procedures for providing efficient and effective treatment.

Air Medical Transport

Nebraska

Nebraska has its own air medical association and is working to improve service, but currently air medical transport is not always available when needed because of limited services offered.

Arkansas

Emergency air medical transport is provided by eight different service areas. A request for air assistance can only be made by EMS or state patrol. An effort is under way to develop guidelines for which service area to contact in the event of an incident. The current practice results in some agencies consistently calling the same air medical transport provider regardless of the proximity to the crash scene.

Vermont

There are no Vermont-based air medical transport entities. Medical air service is provided by either Dartmouth-Hitchcock Advanced Response Team Hancock trauma center out of Lebanon, New Hampshire, or LifeNet trauma center out of Albany, New York. Statewide protocols for air medical transport operations are currently being updated.

Telemedicine

Nebraska

Telemedicine, referred to as Teletrauma in Nebraska, is an underutilized resource. Teletrauma is not used between scene of a crash and hospital because of the cost and lack of availability. However, Teletrauma is a valuable resource in a state with broad population distribution such as Nebraska.

Broadband service in the state is improving, which will provide the needed communication backbone.

Arkansas

A pilot project has deployed telemedicine, including live video feeds and various biometrics, between EMS vehicles and emergency departments. Currently, a few vehicles in urban areas have been outfitted with the system. The system would have more impact in a rural environment where transport times are longer, but system expansion depends on the outcome of the pilot project and on funding.

Vermont

Some EMS providers will transmit heart monitoring data, including during transport from the crash scene to the hospital.

Recruiting, Retention, and Training

Nebraska

At a national level, a high turnover in statewide EMS directors creates challenges in developing and implementing meaningful changes in EMS programs. In addition, statewide EMS agencies tend to have an immediate need/crisis-focused approach to EMS programs. These issues make research less of a focus.

A leadership training initiative is under way to improve relations between ambulance services to improve communication and operational integration. The leadership training is designed for ambulance service managers to learn how to better communicate and lead ambulance service personnel. The training has the following sections:

- Listening skills
- Conflict resolution
- Stress awareness
- How to organize and manage a meeting
- Professionalism
- Public relations.

The training is not designed to improve relations with other ambulance services but is designed to improve internal relations which in the long run will help ambulance personnel work with other ambulance services. A train-the-trainer course involves having an EMS coordinator train about 30 instructors to teach ambulance providers how to transport children more safely.

The Community EMS Assessment Program solicits input from individual communities to see what their expectations are for the local ambulance service. The program brings in law enforcement, dispatch, hospital administrators, nursing home administrators, and the general public to gather information and look for opportunities to improve. The interviewee said that the "program is a great idea, but is only as successful as the community wants to make it." Sometimes, the report's recommendations are shelved by the community. Three of the 15 sessions resulted in meaningful changes. Some of the items examined through the program include the following:

- Geographic area
- Finances
- Availability of personnel
- Public relations/image in the community
- Organizational structure of ambulance service.

The Nebraska Volunteer Fire-fighters Association received a grant to look into ways of retaining volunteer EMS staff. Paramedic training to become an EMT offers $300 of reimbursement.

Arkansas

In Arkansas, about 95% of the EMS service providers are private. The remainder is either provided by fire departments or by volunteers. The volunteer providers are all secondary, not primary providers for a given area. Therefore EMS volunteer recruiting/retention is not an issue.

Vermont

Volunteer recruiting and retention is a recognized need in Vermont, especially given the state's low population and rural character. Recruitment is done through various local means, including outreach at fundraisers and county fairs. A statewide effort is under way to support the 13 EMS districts with educational outreach/recruitment programs.

The Office of Public Health Preparedness and EMS is working with the Medical Reserve Corps (MRC) to get more people involved in medical-related volunteer activities. A new position has been created to within the office to head this initiative. MRC participation is expected to generate interest in EMS volunteering as well.

Funding is in place to deploy a "Learning Management System,"an online training tool that will provide EMS training throughout the state.

Idaho

The Idaho EMS Bureau is leading an effort to reach out to EMS providers throughout the state to address challenges that are encountered in recruiting and retaining what is largely a volunteer EMS response force. The legislatively mandated initiative included 16 town hall meetings that were held throughout the state to gather information on current practices and challenges. A report is currently being assembled that will detail what is and not working, and make recommendations.

West Virginia

West Virginia has identified challenges in EMS staff recruitment and retention. The number of volunteers available fluctuates depending on job availability in the area. This is a particular challenge in West Virginia where the coal mining industry generates dynamic labor demands. They have programs in place to visit schools to deliver a recruiting message. Other notes from the interview include the following:

- E911 has proven an effective tool. It is often the main tool that dispatchers use to locate a crash and route emergency responders to the scene.
- Key partnering agencies include the West Virginia DOT, the Department of Homeland Security, and the Governor's Highway Safety Program. Much collaboration is also required with neighboring states give West Virginia's geographic characteristics.
- The Medical Command Process provides EMS staff with medical guidance during a response. Information is available both online and by phone.
- The EMS community collaborated with the West Virginia DOT to write the state's NHTSA Safety Plan.
- West Virginia is working toward greater interoperability in its communication systems. Agencies targeted for shared communication capabilities include fire, police, hospital, and EMS.
- The state EMS department is conducting a performance improvement initiative that is reaching out to the EMS community to discuss best practices and look for opportunities to make improvements. The initiative is aimed at taking a proactive look at what changes can be made.

Tribal EMS

Nebraska

Nebraska has three tribal ambulance services. The statewide EMS program is working closely with cardiac-related cases with two of the tribes, an area of opportunity for improved patient outcomes. Work is under way to review data being collected, and work with the tribal EMS providers in areas they may need to improve.

Arkansas

There are no tribal lands in Arkansas.

Vermont

There are no tribal lands in Vermont.

Interagency Cooperation and Coordination

Arkansas

The state EMS community meets quarterly with the DOT and the Highway Safety Department. These agencies work collaboratively with the EMS community to provide good service. In rural areas, the local EMS providers have good working relationships with their DOT, fire department, and law enforcement counterparts.

Vermont

The Vermont EMS Office collaborates with the Office for Rural Health and the Governor Highway Safety Program on EMS-related issues in rural areas. Federal funding is provided through HRSA, NHTSA, and the state Department of Public Safety. EMS Office staff also sits on the Traffic Record Coordinating Committee, which meets monthly.

Idaho

StateComm manages traffic incidents on the state highway system, dispatches ITD highway maintenance personnel and equipment statewide, and operates much of the traffic operations-related infrastructure, including CCTV, DMS, 511 system, and HAR—even though ITD is not co-located at this facility. StateComm staff follows ITD policy for things such as message selection for DMS. Staff consults ITD when nonstandard messages are required, such as for presence of smoke from wildfires that are present along a roadway corridor. StateComm monitors weather data from the National Oceanic and Atmospheric Administration out of Spokane, Washington; Missoula, Montana; Salt Lake City, Utah; and Pocatello and Boise, Idaho, and distributes key information to counties, Bureau of Homeland Security, air medical agencies, and Idaho Power as warranted. StateComm is also the primary state warning point for North American Warning Activation System, part of the Federal Homeland Security system and the primary activation center for the Emergency Alert System.

Planning and Innovation

West Virginia

Another relevant effort in West Virginia is the Governor's Highway Safety Program. EMS representatives assisted in writing the program's strategic plan. The plan addresses elements such as motorcycle safety, including safety awareness and helmet laws.

The EMS community was involved in the West Virginia DOT Highway Safety Task Force. Some aspects of this study included the following:

- Engineering solutions, such as center line rumble strips and median cable barrier
- EMS response times
- Legislative recommendations, including primary seat belt law, primary texting law (currently in place), and secondary cell phone usage law (set to become primary in July 2013).

The OASIS project will generate performance metrics for these initiatives.

Other

Nebraska

Of 46 trauma centers in Nebraska, about 30 are critical access hospitals. Critical access hospitals are generally in rural areas. Once a hospital is identified as critical access, it is eligible for special funding. Critical access certification is dependent on the level of training, the amount of hospital beds, the level of care provided, and other factors. The designation is reviewed every 3 years. Trauma centers have different education requirements. A breakdown of the 46 trauma centers in Nebraska follows:

- Level 1 (comprehensive), one center: Omaha
- Level 2 (access), three centers: Lincoln, Carney, and Scotts Bluff
- Level 3 (general), five centers
- Level 4 (basic), 46 centers

There is interest in partnering with the anti-texting and seat belt use education outreach efforts.

Vermont

Vermont has two levels of licensed EMS agencies. EMS-licensed first responder units are generally volunteer-based and use their personal vehicles or fire rescue vehicles to respond to an incident. Their personnel are certified or licensed by the state as EMRs or EMTs and are either associated with the local fire department, or are stand-alone (referred to as "fast" squads). "Transporting" EMS agencies generally arrive on the scene after the first responders and use ambulances to transport patients for hospital care. There are about 90 transporting EMS and 90 EMS-licensed first responder units within the state. The Vermont EMS Office is looking into these relationships to see if EMS resources are properly aligned. Recommendations will likely include improvements in dispatch functions and establishing quality control procedures. Legislation was recently created that establishes an annual EMS funding source for training, education, and future needs.

DEPARTMENT OF TRANSPORTATION INTERVIEW REVIEW AND SUMMARIZATION

DOT interview findings are summarized into one of nine topic areas:

- Record linkages/data metrics
- Crash detection/locating/reporting
- Road condition reporting
- Dispatching
- On-scene and transport issues
- Air medical transport
- Recruiting, retention, and training
- Tribal EMS
- Interagency cooperation.

Four states (Idaho, Arkansas, Vermont, and Nebraska) were selected for a follow-up interview.

Idaho

The interview was conducted with the Highway Safety Manager with the Idaho Transportation Department (ITD).

Arkansas

The interview was conducted with the assistant division head of Planning and Research, and the section head of Safety within the Arkansas DOT.

Vermont

The interview was conducted with the traffic safety and pavement manager of the Vermont Agency of Transportation.

Nebraska

The interview was conducted with the NDOR state traffic engineer.

Record Linkages and Data Metrics

Idaho

There are efforts under way to link crash records to trauma registry to provide a more robust database. Crash reporting currently does not indicate injury severity, outcome, or medical costs.

At one time, Idaho EMS personnel placed a medical ID band on patients to track them from the field through to the treatment they received. The practice was discontinued because of challenges in getting emergency departments to retain the bands and process the data when patients were admitted.

Vermont

Crash data are housed in the traffic safety office. A system is being deployed to place EMS records online. It is hoped that these record systems will be connected in the future.

Nebraska

Data collection forms are being updated to allow for law enforcement to indicate if there is a secondary crash. Law enforcement CAD does not integrate with EMS CAD or traffic management software.

Frequent requests for workshops and good attendance at those held indicate a desire for better and more data.

Crash Detection, Locating, and Reporting

Idaho

The Ada County Highway District manages the regional TMC for the Boise area. The TMC supports EMS by providing traffic congestion information.

Vermont

Enhanced reference mile markers have been placed to ease location identification by callers.

Nebraska

Access to CCTV cameras is being provided to PSAPs in Douglas County (Omaha area).

Road Condition Reporting

Idaho

ITD and StateComm jointly operate a Condition Acquisition and Reporting System (CARS) 511 traveler information system. This system provides more functionality than conventional 511 systems, including real-time information online and by phone on road closures, special events, weather events, and major traffic incidents. A CARS Mayday project is under way to examine the capabilities of automatic crash notification (see description provided in Idaho EMS Case Example).

StateComm operates several Highway Advisory Radio stations in remote areas. The system is used to inform travelers of weather events and major incidents.

ITD operates a Road Weather Information System that provides road weather information to the public and EMS community.

Arkansas

Traffic management plans are developed for major construction projects. These plans include EMS stakeholders when projects are being done in major metropolitan areas, or along interstate roadways.

The DOT posts road construction information and weather-related road condition information on their website in text and map form. No 511 system is in place and no direct communication with EMS providers is done regarding road condition information.

Vermont

Road conditions are communicated through voice radio to state police from the statewide traffic management center.

Nebraska

Nebraska uses 70 environmental sensor stations to provide road condition information on 30-mile segments of roadway through Meridian Environmental. Weather information is available through the 511 traveler information service.

Dispatching

Idaho

The statewide radio system is supported by StateComm.

Arkansas

Arkansas has a statewide wireless information network. This network is used by the highway police (DOT employees) as well as other first responders for communication. See http://www.awin.arkansas.gov/systemInformation/Pages/usage.aspx for more information.

Vermont

Vermont has a statewide radio network for maintenance and other transportation-related dispatch and uses a central dispatching location. The interviewee did not believe this network is interoperable with EMS networks; therefore, the information hand-off is between dispatchers.

Nebraska

Deployment of an interoperable voice and data radio network is under way. Handheld radios are available for EMS use.

On-Scene and Transport Issues

Idaho

StateComm monitors CCTV along key roadways to aid in managing crash scenes. Idaho responders understand the importance of quick incident clearance to minimize the occurrence of secondary crashes and the disruption of traffic flow that impacts commerce.

Idaho is pilot testing a Crash Help system that improves patient care in the field. The system also reduces the amount of time that EMS personnel spend at the scene of a crash by making information communications more efficiently (see description provided in Idaho EMS Case Example).

Arkansas

DOT staff strives to minimize traffic disruptions created by incidents. Highway police officers receive work zone and traffic incident management training on best on-scene practices, but their primary role is in heavy commercial vehicle enforcement and permitting. Arkansas State Police is the designated state agency for public safety, and along with local police/sheriff departments is primarily responsible for handling crash scenes.

Air Medical Transport

Idaho

ITD is starting a research project to examine the feasibility of installing a series of helipads along rural high-crash corridors to facilitate medical transport by air. Helicopters currently require a full roadway closure for a significant amount of time, creating safety and delay impacts. Placing designated landing sites off the roadway right-of-way could provide an improved evacuation practice. The EMS vehicle would transport a patient to the nearest landing site where the patient transfer could be done away from the roadway. The research project will examine crash data and cost to determine the feasibility of moving forward with deployment.

Recruiting, Retention, and Training

Idaho

Because Idaho is largely a rural state, ITD maintenance workers are often the first to come upon crash scenes. ITD requires all maintenance personnel to be trained in cardiopulmonary resuscitation (CPR) and basic first aid so they can render aid in these emergency situations. Several maintenance workers have more advanced training, including EMT certification. Refresher courses are required to keep training current. A culture of maintenance staff providing emergency aid exists, and is made clear to new hires. The StateComm dispatchers have medical dispatcher certification, allowing them to provide remote support as needed.

Vermont

Staff has been trained on incident management through the I-95 Corridor Coalition. Outreach between transportation and fire departments/EMS has been discussed, but there is no momentum for further action.

Nebraska

Traffic incident management is taught to NDOR maintenance personnel. This generates some interest in getting further training, such as CPR.

Some efforts have been made through workshops to engage with fire departments to use NDOR resources, such as advanced warning signs. There is some interest in using safety funds for this engagement.

Tribal EMS

Nebraska

Tribal governments provide law enforcement, but EMS is provided by non-native personnel.

Interagency Cooperation

Idaho

The ITD highway safety manager interviewed for this case example was recently appointed to the EMS Advisory Committee, the first time that ITD has been represented on this committee. This role will provide an opportunity to strengthen ties between the transportation and EMS communities.

StateComm is part of the Idaho Department of Health and Welfare. StateComm employees perform traffic operations functions at the center, including traveler information and traffic surveillance functions. Since these employees are part of the health department, they are more connected to the EMS community than a conventional DOT-operated TMC would be, and are well equipped to provide effective information to EMS personnel.

StateComm has performed traffic operations functions since the EMS Bureau deployed a statewide radio system. ITD contracted with the EMS Bureau to use this communication backbone to provide dispatch functions to ITD maintenance vehicles in the state's six districts. Maintenance vehicles coordinate snow plowing and other maintenance operations directly with StateComm. This role evolved into StateComm taking on more traffic operations functions.

StateComm is co-located with Idaho State Police.

Arkansas

The DOT works with the Governor's Highway Safety Office (part of the Arkansas State Police) on NHTSA grants that are used for safety improvements. Representatives from various agencies are on the SHSP steering committee that provides valuable input for improving highway safety in the state. The participating agencies are shown in the following list:

- Arkansas State Highway and Transportation Department, and its Arkansas Highway Police division
- Arkansas State Police, and its Arkansas Highway Safety Office division
- Arkansas Department of Health
- Arkansas Department of Finance and Administration
- Arkansas Administrative Office of the Courts
- Little Rock Police Department
- Metroplan
- Pulaski County
- West Memphis Metropolitan Planning Organization
- FHWA
- FMCSA
- NHTSA.

Vermont

The agency has had some success coordinating and partnering with EMS agencies in the SHSP framework. Value is seen in more interaction with the state department of health and EMS.

Nebraska

Most planning and collaboration with EMS is pre-incident and during-incident review. NDOR typically assists with road closures.

CHAPTER FIVE

CONCLUSIONS

INTRODUCTION

The synthesis examined a number of topic areas related to emergency medical services (EMS) response to rural crashes from both the EMS provider and transportation system steward perspectives. This chapter summarizes key findings, outlines possible areas of future study, and presents conclusions drawn from the literature search, survey, and interview data collection efforts.

There are numerous efforts to characterize and improve EMS response to rural crashes, but these have tended to be conducted by individual agencies, generally covering a single state as the largest area of action. National efforts have focused on creating standards for care and data management structures, or have developed strategies for other units of government to implement. Although a sample of 14 states was used to prepare the synthesis, care should be taken to avoid generalizing to the remaining 36 states, as geography, demographics, and local needs may vary substantially.

This chapter is organized into five sections to clearly synthesize information across a wide variety of functional areas:

- Dispatch, including crash detection and reporting, road condition reporting, dispatching functions, and communication systems.
- Trauma care, including equipment and preparation, on-scene and transport issues, air medical transport, telemedicine, tribal EMS, and care protocols and procedures.
- EMS management, including staff recruiting, retentions and training, interagency cooperation and coordination, and planning and innovation.
- Data inclusion with retrospective and real-time data linkages and data metrics.
- Areas of future study.

DISPATCH

Studies have shown that using Global Positioning System (GPS) guidance systems for emergency responders can reduce the time from departure to arrival on-scene; however, there are important limitations. The effect of GPS guidance devices is more pronounced on longer trips, with the greatest impact on trips over 20 miles. The usefulness of these devices is also perceived by users to be greater in areas with complex travel patterns (e.g., one-way streets) or areas with poorly marked roadways and addresses. Limitation on effectives were noted where users were not familiar with the devices, or the underlying geographic data were incomplete or incorrect. As a result, some agencies have curtailed their use of GPS in favor of paper maps. The majority of survey respondents used GPS guidance of some sort, indicating that some utility is found in GPS guidance for emergency responders.

Automated Crash Notification (ACN)/ Advanced Automatic Crash Notification (AACN) pilot programs were reported by one survey respondent. Studies have shown that ACN can reduce crash to notification times to no more than 1 minute, potentially saving several minutes of overall response time. AACN systems expand on the ACN concept by communicating data such as restraint use, air bag deployment, change in velocity, and direction of impact to provide insight into the severity of injuries to the crash occupants. Data are not yet available on the effect of AACN systems on patient outcomes or the reliability of vehicle sensor systems.

All of the DOT respondents indicated that they had systems to monitor and report roadway conditions, including weather, construction, and maintenance activities that can affect traffic flow.

Interoperable communication systems are in place or actively being developed by all states covered in this synthesis. Although these systems greatly enhance the ability for emergency responders from different jurisdictions to communicate with each other, they are primarily used for voice communications and low-data-rate electronic information, making them unsuitable for higher-bandwidth applications such as multimedia telemedicine.

TRAUMA CARE

In the survey of EMS personnel, 50% indicated that equipment issues had delayed departures, and the same number said that there was no checklist or standard procedure to ensure that equipment was available an in working condition. In the case examples, West Virginia reported that the EMS community has inspection criteria for vehicles and was not aware of readiness issues in the state.

A number of documents have been produced to provide guidance for on-scene care and crash scene traffic management. Half of the EMS survey respondents replied that there were standard protocols and procedures in place for care in their state, and approximately the same number indicated that there were programs in place to evaluate these processes. However, scant data are available to determine the effect of standardizing protocols on patient outcomes.

The use of air medical transport is limited by its availability in rural areas. Further, the impact on patient outcomes is a subject of debate. Research appears to establish that ground transport can have shorter crash to hospital arrival times for distances less than 100 km. Also, the positive effects of air transport appear to be limited to only the most severely injured patients. This conflicts with dispatch requests for air transport, which are typically based on distance from a trauma facility rather than injury severity, as this information is generally not available during initial dispatch. There may be a synergy between AACN, which can indicate severity and more efficient use of air transport for rural crash patients.

The efficacy of center-to-center telemedicine systems in improving patient outcomes is still under study. Objective measures have not uniformly shown improvements in the quality or effectiveness of care; however, many of the users surveyed believed that these systems were helpful in providing treatment. The use of scene-to-center telemedicine is not well understood in rural environments, as the availability of a supporting communication system is a limiting factor.

DATA

Although information about crashes, transport times and injuries is routinely collected, only two survey respondents replied that they collected any data related to patient outcomes and no costs or agency compensation. This lack of information makes it difficult to assess the efficacy of medical interventions or to determine their cost-effectiveness. Linking these records has proven challenging as there are no direct identifiers to allow them to be related, and as a result statistical matching approaches have been applied with some success. A program to collect crash scene and patient data during response and transmit it to hospital staff has been deployed as an evaluation in Idaho. This approach allows for direct connection between data collected at the scene and patient outcome data as the information is part of the patient care record.

EMERGENCY MEDICAL SERVICES MANAGEMENT

Data regarding performance of tribal EMS providers are scarce. During the EMS case example interviews, one respondent identified cooperation with tribal providers on cardiac-related cases as an opportunity to improve patient outcomes. Anecdotal evidence indicates that the practices used by tribal providers are improving, but objective measures are not available. Ensuring cooperation and coordination of resources may offer an opportunity to improve care on and near tribal lands.

All EMS case example participants identified concerns over the ability to recruit, retain, and train EMS personnel. The majority of EMS survey respondents indicated that staffing levels had adversely affected response times. Only one survey reported that there was any program in place to recruit volunteers from other agencies [such as department of transportation (DOT) maintenance staffs]. Idaho is currently studying this issue through a public participation process, and most states have a recruiting effort though a presence at public events or appearances at schools.

All EMS and DOT respondents for both the surveys and case examples indicated that an ongoing relationship existed and regular exchanges of information occurred. These relationships have been the foundation for incident management coordination and will play a key role both for direct cooperation for scene management (e.g., maintenance, traffic control) and for enabling record linkages.

AREAS OF FUTURE STUDY

Based on the information collected for this report, several areas are presented as possible avenues of future study:

- Although evidence suggests that using GPS guidance can reduce time to arrival on-scene, particularly for longer distance, some agencies avoid using the devices because of difficulties with use or poor quality geographic data. To address these issues, a standard or method of verification of the mapping data used by devices and guidelines for training users could be implemented.
- AACN deployments have largely been ad hoc through OnStar or a similar service, or have been conducted as evaluations and tests. Coordinated deployment on a larger scale to mainstream the use of automatic notifications could allow for a more complete assessment of its impact on arrival times.
- AACN offers the potential to provide an early assessment of the risk of severe injury, which can assist providers with predeparture preparation and dispatchers with responder selection (e.g., air transport, rescue units). Little is known about the long-term reliability of vehicle-based sensors for these applications or AACNs effect on patient outcomes.
- EMS responses indicate that access to road condition information is valuable, but not easily accessible in the predeparture sequence of events. All DOTs provide near real-time information on state-jurisdiction roadways, including construction information and roadway

condition. EMS personnel's inability to easily access data may be addressable through purpose-designed interfaces and appropriate access devices.

- All states included in the study have or are deploying interoperable digital communications networks that encompass a number of agencies. These networks primarily serve voice and low-bandwidth data communications functions, which limit some applications such as telemedicine using images or audio/video streams. The impact of low bandwidth availability on these applications and the feasibility of enabling higher data rates could be explored.
- With equipment condition or availability identified as a factor in response times, methods for ensuring readiness may be a useful tool.
- Use of air medical transport and its impact on patient outcomes does not have definitive evidence; however, it appears that patient injury severity rather than distance is the factor that benefits most from air transport. Investigation of injury-severity based dispatch using AACN or other inputs may provide a way to maximize the cost-effectiveness of air medical transport.
- The literature review revealed conflicting information regarding the efficacy of telemedicine in the center-to-center environment. Further studies of objective measures of patient outcomes may provide insight into the viability and effectiveness of telemedicine applications.
- The use of telemedicine in the scene-to-center or mobile telemedicine is dependent on the availability of suitable communications networks to transport the data. Investigation of the limits of data requirements and how these can be met with existing or augmented networks will define the broad parameters of mobile telemedicine uses and limits of deployment.
- The existing efforts to collect real-time patient data and link that information to other record sets should be examined to determine the effect on patient outcomes. As a related effort, ways to connect outcomes to cost data will permit cost-effectiveness analysis that is not currently possible.
- There appears to be little data on differences in procedures or outcomes between tribal and nontribal EMS providers. Investigation of opportunities to work with tribal governments to assess performance, and enhance services through coordination, unified training or care protocols, and sharing of resources may highlight way to improve care for patients on or near tribal lands.

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APPENDIX A

Survey Questionnaires

NCHRP 43-15 EMS Response to Motor Vehicle Crashes in Rural Areas (EMS Agency Survey)

Dear State EMS Director:

The Transportation Research Board (TRB) is preparing a synthesis of practice on *Emergency Medical Services Response to Motor Vehicle Crashes in Rural Areas*. This is being done for the National Cooperative Highway Research Program (NCHRP), under the sponsorship of the American Association of State Highway and Transportation Officials (AASHTO), in cooperation with the Federal Highway Administration (FHWA).

The synthesis will collect data on emergency medical response practices in rural areas, focused on effective, innovative practices. This survey will gather information from your state and will be the basis for a series of follow-up interviews to collect more detailed data on specific approaches or study results.

This survey questionnaire is being distributed to state Emergency Medical Service directors. If you are not the appropriate person at your agency to complete this survey, please forward it to the correct person.

Please complete and submit this survey questionnaire by July 13, 2012. If you have any questions, please do not hesitate to contact our principal investigator Erik Minge at eminge@srfconsulting.com or 763-475-0010.

Questionnaire Instructions:

1. To view the entire questionnaire before you begin, click on the following link: http://surveygizmolibrary.s3.amazonaws.com/library/64484/NCHRP_4315_EMS.pdf.

2. To print the survey, click on the link above and print using “control p.”

3. To save your partial answers, or to forward a partially completed questionnaire to another party, click on the “Save and Continue Later” link at the top of your screen. A link to the partially completed questionnaire will be e-mailed to you from SurveyGizmo. To return to the questionnaire later, open the email from SurveyGizmo and click on the link. To invite a colleague to complete part of the survey, simply click on the “Save and Continue” link and enter your colleague’s e-mail address. Please note that the questionnaire can be saved and passed around multiple times, but respondents must use the link e-mailed from SurveyGizmo. We suggest using the “Save and Continue Later” feature if there will be more than 15 minutes of inactivity while the survey is opened, as some firewalls may terminate because of inactivity.

4. To view and print your answers before submitting the survey, click forward to the page following question 39. Print using “control p.”

5. To submit the survey, click on “Submit” on the last page.

When responding to the survey, please focus to the extent possible on practices for crash response in rural areas. For the purpose of this survey, the U.S. Census definition of “rural” is recommended, meaning areas outside of urban clusters with a population of 50,000 or more.

Thank you very much for participating in this survey!

Contact Information

Please enter the date (MM/DD/YYYY).*

Please enter your contact information.

First Name*: ______________________________

Last Name*: ______________________________

Title*: ______________________________

Agency/Organization*: ______________________________

Street Address: ______________________________

Suite: ______________________________

City*: ______________________________

State*: ______________________________

Zip Code*: ______________________________

Country: ______________________________

E-mail Address*: ______________________________

Phone Number*: ______________________________

Fax Number: ______________________________

Mobile Phone: ______________________________

URL: ______________________________

Data

1) For motor vehicle crashes, does your agency collect data on any of the following (check all that apply)?

[ ] Urban versus rural location of crash

[ ] Crash cause

[ ] Injury severity

[ ] Responder type

[ ] Number of responding units

[ ] Response times

[ ] Patient destination

[ ] Patient transfers

[ ] Patient transport times

[ ] Patient outcomes (by injury severity or other metric)

[ ] Costs or cost-effectiveness of crash-related emergency medical care

[ ] Charges billed to patients

[ ] Charges collected

[ ] Compensation of agencies/providers

2) Do you link crash data to other data management systems, such as (check all that apply)?

[ ] Driver licensing

[ ] Vehicle registration

[ ] Pavement condition management

[ ] Hospital patient information

[ ] Insurance records

[ ] Other (please specify):

Response Enhancement Initiatives—Dispatch Coordination

3) Are you aware of specific state initiatives or existing multidisciplinary public safety answering points (PSAPs) (i.e., 911 call center) coordination programs to address rural crash dispatching, routing, response, patient care and roadway maintenance activities?

☐ Yes (please describe): ______________________

☐ No

4) What tools are used to route responders to rural crash scenes (check all that apply)?

[ ] Guided by dispatchers

[ ] Dispatch software

[ ] Agency provided in-vehicle GPS guidance devices (including smart phones)

[ ] Personal GPS guidance devices (including smart phones)

[ ] Paper maps

[ ] Other (please specify):

5) In a rural area of your state that you consider typical, by what means could an EMS provider at a crash scene directly communicate with a local “highway operations responder,” such as signing, electrical or bridge repair crews (check all that apply)?

[ ] Through an interoperable radio system

[ ] Through a system of “patched” or interconnected radio systems

[ ] Instant, text or e-mail messages

[ ] Cell phones

[ ] Other (please specify):

6) Is there a state-level, regional-level, or multi-disciplinary organization that works toward improving PSAP functions?

☐ Yes (please describe): ______________________

☐ No

Response Enhancement Initiatives—Telemedicine

7) Do EMS providers in your state use telemedicine/telepresence technologies for medical treatment?

☐ Yes

☐ No

8) Who are the typical telemedicine user groups (check all that apply)?

[ ] Emergency department staff

[ ] Trauma center staff

[ ] Other physician specialists (please specify):

[ ] Medical scene responders (i.e., EMT/paramedic/nurse, please specify):

[ ] Other scene responders (i.e., fire/law enforcement, please specify):

9) What sort of data are typically exchanged by telemedicine applications (check all that apply)?

[ ] Images

[ ] Audio recordings

[ ] Live audio

[ ] Video recordings

[ ] Live video

[ ] Text messages

[ ] Biometric data (EKG, etc.)

10) Where is telemedicine typically used (check all that apply)?

[ ] Scene to nearest emergency department

[ ] Scene to trauma center

[ ] Scene to dispatch center or central communications center

[ ] Emergency department to trauma center

[ ] Emergency department to other specialty care facility (please specify):

11) How is data transported for the telemedicine applications in rural areas (check all that apply)?

[ ] Dedicated radio network

[ ] Cellular network

[ ] Satellite phone

[ ] Dedicated fiber optic connection

[ ] Leased data services (T-1/DS-1/EOC, etc.)

[ ] Other (please specify):

12) How is telemedicine typically used (check all that apply)?

[ ] Guidance for field responders

[ ] Preparation for receiving emergency physicians

[ ] Consultation by physicians with specialists

[ ] Record-keeping/training

[ ] Other (please specify):

Response Time Reduction

13) Is there an active effort by your agency to reduce the response times for rural crashes?

☐ Yes

☐ No

14) Does your rural crash response time reduction program focus on (check all that apply)?

[ ] Crash detection or reporting

[ ] Identifying crash locations

[ ] Expediting dispatch

[ ] Improved responder stationing

[ ] Improved responder guidance

[ ] Other (please describe):

15) Please rank the following options based on your experience as having the greatest effect on response times (1 is largest effect, 7 is smallest effect):

_______________ Crash detection or reporting

_______________ Identifying crash locations

_______________ Expediting dispatch

_______________ Improved responder stationing

_______________ Improved responder guidance

_______________ Improved coordination of available responders

_______________ Other (please describe in next question):

16) If you ranked an “other” category on the question above, please describe the option here:

17) Through your agency’s response time reduction program, have you been able to quantify impacts for (check all that apply)?

[ ] Time to arrival on-scene

[ ] Patient outcomes

[ ] Costs

[ ] Other (please describe):

18) Are response times used as a measurement in a system quality assurance process?

☐ Yes

☐ No

On-site Care Procedures and Protocols

19) Does your state mandate local use of trauma triage, treatment, and transport procedures and protocols?

☐ Yes

☐ No

20) If uniform procedures and protocols are mandated, are these uniform for all jurisdictions?

☐ Yes

☐ No

☐ N/A

21) Is there an active effort by your agency to evaluate or revise on-site care procedures and protocols?

☐ Yes

☐ No

22) If there is an active effort to evaluate or revise on-site procedures and protocols, does your effort focus on (check most applicable)?

[ ] Patient treatment and stabilization procedures

[ ] Patient triage

[ ] Destination routing

[ ] Pre-arrival (EMD) instructions

[ ] N/A

[ ] Other (please describe): ____________________

Air Transport Use

23) Is air transport of crash victims commonly used in your area?

☐ Yes

☐ No

24) Do you collect information on the total annual number of air transports used for rural crash response?

☐ Yes

☐ No

25) When air transport is used, what is it used for (check all that apply)?

[ ] Crash scene to local or regional emergency department

[ ] Crash scene to trauma center

[ ] Emergency department to trauma center

[ ] Other (please describe):

26) Have any studies been conducted in your state to determine the effect of air transport on patient outcomes?

☐ Yes (please describe): ____________________

☐ No

27) Who is able to cancel a request for air transport (check all that apply)?

[ ] PSAP dispatcher or EMD

[ ] Scene commander

[ ] On-scene medical personnel

[ ] Other (please specify):

28) What medical personnel typically fly on aircraft (check all that apply)?

[ ] EMT

[ ] Paramedic

[ ] Flight nurse

[ ] Flight physician

[ ] Other (please specify):

Responder Preparation/Pre-Dispatch Activities

29) Is there a standard checklist used by emergency responders to ensure proper equipment is available for crash response?

☐ Yes

☐ No

30) Are responders able to quickly check for road conditions and closures before departing for the scene?

☐ Yes

☐ No

31) If responders are able to check conditions, how is this most commonly done?

[ ] Voice communication with dispatch

[ ] Telephone call to information service (511, etc.)

[ ] Web-based or other information service

[ ] Other (i.e., built into GPS, please describe): ______________________

32) Has vehicle or equipment condition ever affected the time needed to respond to a crash?

☐ Yes (please describe): ______________________

☐ No

Staffing

33) Are most EMS responders:

[ ] Full-time staff

[ ] Part-time staff

[ ] Volunteer

34) How are responders (EMT, emergency vehicle operator, paramedic) recruited (check all that apply)?

[ ] Partnering with public agencies

[ ] Advertising in community publications

[ ] Advertising in industry publications

[ ] Other (please describe):

35) Are there any programs or incentives to encourage employees of other disciplines (e.g., highway operations responders) to acquire EMS certifications or licensure?

☐ Yes

☐ No

36) Has staffing levels frequently affected response quality or time?

☐ Yes

☐ No

37) Do you partner with any of the following groups to improve crash-related response (check all that apply)?

[ ] State departments of transportation

[ ] Public health agencies

[ ] PSAPs

[ ] Other local emergency responders

[ ] Other local emergency medical services providers

[ ] Hospitals

[ ] Other (please describe):

Innovative Practices Used or Under Development

38) Is your agency engaged in using, developing, or testing new practices in any of the following areas (check all that apply)?

[ ] Real-time road/weather data

[ ] Vehicle telematics (such as automatic vehicle location, traffic signal pre-emption, etc.)

[ ] Incident/crash detection

[ ] Incident/crash severity determination

[ ] Training or recruitment practices

[ ] Triage and destination routing and decision making

[ ] Funding or budgeting

[ ] Other (please describe):

Follow-up Information

39) Would you be available to provide additional information through a follow-up interview?

☐ Yes

☐ No

Contact Information Review

Thank You!

Thank you for taking our survey. Your response is very important to us. If you have any questions or comments, please feel free to contact Erik Minge at:

E-mail: eminge@srfconsulting.com

Phone: 763-475-0010

Mailing Address: SRF Consulting Group, One Carlson Parkway, Suite 150, Minneapolis, MN 55447

NCHRP 43-15 EMS RESPONSE TO MOTOR VEHICLE CRASHES IN RURAL AREAS (DOT SURVEY)

Dear State Safety Engineer,

The Transportation Research Board (TRB) is preparing a synthesis for practices on *Emergency Medical Services Response to Motor Vehicle Crashes in Rural Areas.* This is being done for the National Cooperative Highway Research Program (NCHRP), under the sponsorship of the American Association of State Highway and Transportation Officials (AASHTO), in cooperation with the Federal Highway Administration (FHWA).

The synthesis will collect data on emergency medical response in rural areas, focused on effective, innovative practices. This survey will also form the basis for a series of follow-up interviews to collect more detailed data on specific approaches or study results.

This survey questionnaire is being distributed to members of the AASHTO Highway Traffic Safety Subcommittee on Safety Management. If you are not the appropriate person at your agency to complete this survey, please forward it to the correct person.

Please complete and submit this survey questionnaire by July 13, 2012. If you have any questions, please do not hesitate to contact our principal investigator Erik Minge at eminge@srfconsulting.com or 763-475-0010.

Questionnaire Instructions

1. To view the entire questionnaire before you begin, Click on the following link: http://surveygizmolibrary.s3.amazonaws.com/library/64484/NCHRP_4315_DOT.pdf

2. To print the survey, click on the link above and print using "control p."

3. To save your partial answers, or to forward a partially completed questionnaire to another party, click on the "Save and Continue Later" link at the top of your screen. A link to the partially completed questionnaire will be e-mailed to you from *SurveyGizmo.* To return to the questionnaire later, open the e-mail from *SurveyGizmo* and click on the link. To invite a colleague to complete part of the survey, simply click on the "Save and Continue" link and enter your colleague's e-mail address. Please note that the questionnaire can be saved and passed around multiple times, but respondents must use the link e-mailed from *SurveyGizmo. We suggest using the "Save and Continue Later" feature if there will be more than 15 minutes of inactivity while the survey is opened, as some firewalls may terminate owing to inactivity.*

4. To view and print your answers before submitting the survey, click forward to the page following question 39. Print using "control p."

5. To submit the survey, click on "Submit" on the last page.

When responding to the survey, please focus to the extent possible on practices for crash response in rural areas. For the purpose of this survey, the U.S. Census definition of "rural" is recommended, meaning areas outside of urban clusters with a population of 50,000 or more.

Thank you very much for participating in this survey!

Contact Information

Please enter the date (MM/DD/YYYY).*

Please enter your contact information.

First Name*: ______________________________

Last Name*: ______________________________

Title*: ____

Agency/Organization*: ______________________________

Street Address: ____________________________________

Suite: ____

City*: ____

State*: ____

Zip Code*: ____

Country: ____

E-mail Address*: ___________________________________

Phone Number*: ____________________________________

Fax Number: _______________________________________

Mobile Phone: ______________________________________

URL: ____

Data Collected

1) Does your agency collect data on any of the following (check all that apply)?

[ ] Number of rural crashes

[ ] Cause of rural crashes

[ ] Rural crash fatality rates

[ ] Number of emergency medical responses to rural crashes

[ ] Ambulance or rescue unit response times

[ ] Patient outcomes

[ ] Emergency or trauma related patient transfers

[ ] Costs or cost-effectiveness of crash-related emergency medical care

Response Enhancement Initiatives—Dispatch Coordination

2) Does your department co-locate maintenance dispatch functions with emergency response dispatch?

☐ All

☐ Some (please specify approximate percent): ____________________

☐ None

3) Does your department use communication systems that interoperate directly with emergency response?

☐ Yes

☐ No

4) How does your department communicate with emergency responders from different agencies or jurisdictions (check all that apply)?

[ ] Through an interoperable radio system

[ ] Through a system of “patched” or interconnected radio systems

[ ] Instant, text or e-mail messages

[ ] Cell phones

[ ] Other (please describe):

5) Does your department provide real-time roadway condition information?

☐ Yes

☐ No

6) If real-time information is provided, how is it made available (check all that apply)?

[ ] 511 telephone service

[ ] Web-based information service

[ ] Dedicated mobile applications

[ ] Dedicated hotline for EMS

[ ] Voice radio system broadcasts

[ ] Other (please specify):

7) How do emergency responders from different agencies or jurisdictions typically communicate in rural areas (check all that apply)?

[ ] Through an interoperable radio system

[ ] Through a system of “patched” or interconnected radio systems

[ ] Instant, text or e-mail messages

[ ] Cell phones

[ ] Other (please describe):

8) Does your department participate in an on-going effort to improve rural crash response or care?

☐ Yes

☐ No

Response Enhancement Initiatives—Response Coordination

9) Does your state use the FHWA Traffic Incident Management Handbook for training and procedure development?

☐ Yes

☐ No

10) Have you implemented strategies outlined in the National Unified Goal for traffic incident management?

☐ Yes

☐ No

11) Do department maintenance staffs regularly assist with rural crash response?

☐ Yes

☐ No

12) If staff assists with response, do they commonly perform (check all that apply):

[ ] Traffic control

[ ] Crash site management assistance

[ ] Traffic control device/roadway and bridge repair when needed

[ ] Other (please describe):

Innovative Practices Used or Under Development

13) Is your department engaged in using, developing or testing new practices in any of the following areas (check all that apply)?

[ ] Real-time road/weather data

[ ] Vehicle telematics (such as vehicle location, traffic signal pre-emption, etc.)

[ ] Incident detection

[ ] Incident severity determination

[ ] Training or recruitment practices

[ ] Funding or budgeting

[ ] Crash scene safety

[ ] Crash scene clearing

[ ] Other (please describe):

Follow-up Information

14) Would you be available to provide additional information through a follow-up interview?

☐ Yes

☐ No

Answer Review

Thank You!

Thank you for taking our survey. Your response is very important to us. If you have any questions or comments, please feel free to contact Erik Minge at:

E-mail: eminge@srfconsulting.com

Phone: 763-475-0010

Mailing Address: SRF Consulting Group, One Carlson Parkway, Suite 150, Minneapolis, MN 55447

APPENDIX B

Raw Survey Numerical Results

EMS Results

STATE																	
Question		MT	IA	AR	NH	SC	NE	ID	SD	WY	WV	KY	KS	VT	MS	No.	%
Please enter the date (MM/DD/YYYY).		6/22/12	7/17/12	7/17/12	7/18/12	8/24/12	6/13/12	8/29/12	6/21/12	6/22/12	9/4/12	9/10/12	9/12/12	9/14/12			
1. For motor vehicle crashes, does your agency collect data on any of the following (check all that apply)?	Urban versus rural location of crash	X			X		X			X	X				X	6	43
	Crash cause									X	X					2	14
	Injury severity	X	X		X		X	X	X	X	X		X	X	X	11	79
	Responder type	X	X		X	X	X		X	X	X			X	X	10	71
	Number of responding units	X	X		X		X		X	X	X			X		8	57
	Response times	X	X	X	X	X	X	X	X	X	X		X	X		12	86
	Patient destination	X	X	X	X	X	X	X	X	X	X		X	X	X	13	93
	Patient transfers	X		X	X		X	X	X	X	X		X	X		10	71
	Patient transport times	X	X	X	X	X	X	X	X	X	X		X	X	X	13	93
	Patient outcomes	X					X									2	14
	Costs or cost-effectiveness of crash-related emergency medical care															0	0
	Charges billed to patients															0	0
	Charges collected															0	0
	Compensation of agencies/providers															0	0
2. Do you link crash data to other data management systems, such as (check all that apply)?	Driver licensing						X									1	7
	Vehicle registration															0	0
	Pavement condition management															0	0
	Hospital patient information						X			X	X					3	21
	Insurance records																0
	Other (please specify):					None	Death certificate	Trauma registry						Public safety			

STATE																	
Question		MT	IA	AR	NH	SC	NE	ID	SD	WY	WV	KY	KS	VT	MS	No.	%
3. Are you aware of specific state initiatives or existing multidisciplinary public safety answering points (PSAPs) (i.e., 911 call center) coordination programs to address rural crash dispatching, routing, response, patient care and roadway maintenance activities?	Yes/No	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No		
	Yes (please describe):	We have an AACN pilot project						Idaho EMS dispatch			OASIS project for purpose of data sharing, Hwy Safety Program…			State coordinated/ operated PSAP system to manage routing, dispatching methods…			
4. What tools are used to route responders to rural crash scenes?	Guided by dispatchers	X		X	X	X	X	X	X	X	X	X	X	X	X	13	93
	Dispatch software			X		X	X	X	X	X	X	X			X	9	64
	Agency provided in-vehicle GPS guidance devices (including smart phones)	X		X	X		X			X	X	X	X	X	X	10	71
	Personal GPS guidance devices (including smart phones)								X	X	X	X	X	X	X	7	50
	Paper maps	X		X	X	X	X		X	X	X	X	X	X	X	12	86
	Other (please specify):							Info relay from DOT			All use dispatch						
5. In a rural area of your state that you consider typical, by what means could an EMS provider at a crash scene directly communicate with a local "highway operations responder," such as signing, electrical or bridge	Through an interoperable radio system	X				X							X			3	21
	Through a system of "patched" or interconnected radio systems					X	X		X		X	X		X		6	43
	Instant, text or e-mail messages															0	0
	Cell phones				X	X	X		X				X	X		6	43
	Other (please specify):			Dis-patch to centers				Relay thru dispatch		None				Relay via dispatch	Through local dispatch		

STATE																	
Question		MT	IA	AR	NH	SC	NE	ID	SD	WY	WV	KY	KS	VT	MS	No.	%
6. Is there a state-level, regional-level, or multi-disciplinary organization that works toward improving PSAP functions?	Yes/No	Yes		Yes	Yes	No	No	Yes	No	No	Yes	No	Yes	Yes	No		
	Yes (please describe):	Our office and Public Safety Bureau in our Dept. of Admin		Unsure	NH Bureau of Emergency Comm. Quality Management Program			SIEC			OASIS project for purpose of data sharing, Hwy Safety Program…		KS Emergency Management	State 911 Board			
7. Do EMS providers in your state use telemedicine/ telepresence technologies for medical treatment?	Yes/No	No	Yes	Yes	No	No	Yes	No	Yes	No	Yes	No	No	Yes	No		
8. Who are the typical telemedicine user groups?	Emergency department staff			X			X		X		X			X		5	36
	Trauma center staff						X		X		X			X		4	29
	Other physician specialists (please specify):								Pharmacy		Blank			Neurology/ pediatrics			
	Medical scene responders (i.e., EMT/Paramedic/ Nurse, please specify):			Blank							Blank			EKG			
	Other scene responders (i.e., fire/law enforcement, please specify):																
9. What sort of data are typically exchanged by telemedicine applications?	Images						X				X					2	14
	Audio recordings															0	0
	Live audio						X		X					X		3	21
	Video recordings								X							1	7
	Live video						X				X					2	14
	Text messages															0	0
	Biometric data (EKG, etc.)			X					X		X			X		4	29

STATE																	
Question		MT	IA	AR	NH	SC	NE	ID	SD	WY	WV	KY	KS	VT	MS	No.	%
10. Where is telemedicine typically used?	Scene to nearest emergency department			X					X					X		3	21
	Scene to trauma center															0	0
	Scene to dispatch center or central communications center															0	0
	Emergency department to trauma center						X		X		X			X		4	29
	Emergency department to other specialty care facility (please specify):								Blank					pediatric			
11. How is data transported for the telemedicine applications in rural areas?	Dedicated radio network:										X						
	Cellular network			X					X		X			X		1	7
	Satellite phone															4	29
	Dedicated fiber optic connection						X				X					0	0
	Leased data services (T-1/DS-1/EOC, etc.)						X		X							2	14
	Other (please specify):															2	14
12. How is telemedicine typically used (check all that apply)?	Guidance for field responders			X												1	7
	Preparation for receiving emergency physicians			X					X					X		3	21
	Consultation by physicians with specialists						X		X		X			X		4	29
	Record-keeping/training								X							1	7
	Other (please specify)																
13. Is there an active effort by your agency to reduce the response times for rural crashes?	Yes/No	No	No	No	No	No	Yes	No	No	Yes	Yes	No	Yes	No	No		
14. Does your rural crash response time reduction program focus on:	Crash detection or reporting										X					1	7
	Identifying crash locations										X					1	7
	Expediting dispatch						X				X					2	14
	Improved responder stationing															0	0
	Improved responder guidance						X			X						2	14
	Other (please describe):															0	0
15. Please rank the following options based on your experience as having the greatest effect on response times (1 is largest effect, 7 is smallest effect)	Crash detection or reporting						2			5	1		1				
	Identifying crash locations						1			6	2		2				
	Expediting dispatch						3			4	3		3				
	Improved responder stationing						6			2	5		4				
	Improved responder guidance						4			3	6		5				
	Improved coordination of available responders									1	4		6				
	Other (please describe in next question):																

STATE																	
Question		MT	IA	AR	NH	SC	NE	ID	SD	WY	WV	KY	KS	VT	MS	No.	%
16. If you ranked an “other” category on the question above, please describe the option here:											N/A						
17. Through your agency’s response time reduction program, have you been able to quantify impacts for (check all that apply)?	Time to arrival on-scene						X				X					2	14
	Patient outcomes															0	0
	Costs															0	0
	Other (please describe):															0	0
18. Are response times used as a measurement in a system quality assurance process?	Yes/No						Yes			Yes	Yes		Yes				
19. Does your state mandate local use of trauma triage, treatment and transport procedures and protocols?	Yes/No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No		
20. If uniform procedures and protocols are mandated, are these uniform for all jurisdictions?	Yes/No	N/A	Yes	Yes	Yes	No	N/A	N/A	Yes	No	Yes	N/A	N/A	N/A	Yes		
21. Is there an active effort by your agency to evaluate or revise on-site care procedures and protocols?	Yes/No	Yes	Yes	No	Yes	No	No	No	No	Yes	Yes	No	Yes	Yes	Yes		
22. If there is an active effort to evaluate or revise on-site procedures and protocols, does your effort focus on:	Patient treatment and stabilization procedures		X	X	X						X		X	X	X	7	50
	Patient triage		X	X	X						X			X	X	6	43
	Destination routin			X	X						X			X	X	5	36
	Pre-arrival (EMD) instructions										X					1	7
	N/A					X	X	X		X						4	29
	Other (Please describe):																

STATE																	
Question		MT	IA	AR	NH	SC	NE	ID	SD	WY	WV	KY	KS	VT	MS	No.	%
23. Is air transport of crash victims commonly used in your area?	Yes/No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
24. Do you collect information on the total annual number of air transports used for rural crash response?	Yes/No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes		
25. When air transport is used, what is it used for?	Crash scene to local or regional emergency department	X	X	X		X		X	X		X		X			8	57
	Crash scene to trauma center	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14	100
	Emergency department to trauma center	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14	100
	Other (please describe):					Inter-facility transfer											
26. Have any studies been conducted in your state to determine the effect of air transport on patient outcomes?	Yes/No	No	No	No	Yes	No	No	No	No	No	Yes	No	No	No	No		
	Yes (please describe):				Air Medical Transport Utilization Review						State Trauma Advis-ory Council						
27. Who is able to cancel a request for air transport (check all that apply)?	PSAP dispatcher or EMD			X						X	X	X	X			5	36
	Scene commander	X		X	X	X	X			X	X	X	X	X	X	11	79
	On-scene medical personnel	X		X	X	X	X	X	X	X	X	X	X	X	X	13	93
	Other (please specify):					Pilot		Agency specific protocol					Local decision				

STATE																	
Question		MT	IA	AR	NH	SC	NE	ID	SD	WY	WV	KY	KS	VT	MS	No.	%
28. What medical personnel typically fly on aircraft? (check all that apply)	EMT																
	Paramedic	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14	100
	Flight nurse	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14	100
	Flight physician															0	0
	Other (please specify):						Inhalation therapist										
29. Is there a standard check-list used by emergency responders to ensure proper equipment is available for crash response?	Yes/No	Yes	No	Yes	Yes	No	Yes	No	Yes	No	Yes	No	No	Yes	Yes		
30. Are responders able to quickly check for road condi-tions and closures before departing for the scene?	Yes/No	No		No	No	No	No	Yes	Yes	No	No	No	Yes	Yes	No		
31. If responders are able to check conditions, how is this most commonly done?	Voice Communica-tion with dispatch	X	X				X	X	X				X	X		7	50
	Telephone call to information service (511, etc.)															0	0
	Web-based or other information service															0	0
	Other (i.e. built into GPS, please describe):												All of the above				
32. Has vehicle or equipment condition ever affected the time needed to respond to a crash?	Yes/No	Yes		No	Yes	No	Yes	Yes	No						Yes		
	Yes (please describe):	Volunteer service has a lot of old vehicles			If ambulance doesn't start, it affects response time		Vehicle was broke down	Mechanical reliability							Improper vehicle maintenance		

STATE																	
Question		MT	IA	AR	NH	SC	NE	ID	SD	WY	WV	KY	KS	VT	MS	No.	%
33. Are most EMS responders	Full-time staff			X		X						X			X	4	29
	Part-time staff							X								1	7
	Volunteer	X	X		X		X		X	X			X	X		8	57
34. How are responders (EMT, emergency vehicle operator, paramedic) recruited (check all that apply)?	Partnering with public agencies			X		X				X	X	X	X	X		7	50
	Advertising in community publications	X		X	X	X	X	X	X	X		X	X	X		11	79
	Advertising in industry publications			X			X	X		X		X					
	Other (please describe):				Word of mouth	Word of mouth		Word of mouth			Training program		EMS website				
35. Are there any programs or incentives to encourage employees of other disciplines (e.g., highway operations responders) to acquire EMS certifications or licensure?	Yes/No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No		
36. Has staffing levels frequently affected response quality or time?		Yes		No	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes		
37. Do you partner with any of the following groups to improve crash-related response (check all that apply)?	State departments of transportation	X		X		X	X	X	X	X	X	X	X	X	X	12	86
	Public health agencies			X			X			X				X	X	5	36
	PSAPs							X						X	X	3	22
	Other local emergency medical services providers			X	X		X	X	X		X	X	X	X	X	10	71
	Hospitals				X		X	X	X	X	X	X		X		8	57
	Other (please describe):						Highway safety							State Dept. Public Safety			

STATE																
Question		MT	IA	AR	NH	SC	NE	ID	SD	WY	WV	KY	KS	VT	MS	No.	%
38. Is your agency engaged in using, developing or testing new practices in any of the following areas (check all that apply)?	Real-time road/weather data												X			1	7
	Vehicle telematics (such as automatic vehicle location, traffic signal pre-emption, etc.)							X					X			2	14
	Incident/crash detection	X														1	7
	Incident/crash severity determination	X														1	7
	Training or recruitment practices				X		X	X		X				X		5	36
	Triage and destination routing and decision making	X		X						X	X			X	X	6	43
	Funding or budgeting									X				X		2	14
	Other (please describe): Is your agency engaged in using, developing or testing new practices in any of the following areas (check all that apply)?																
39. Would you be available to provide additional information through a follow-up interview?	Yes/No	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes		

DOT Results

Question		MS	AR	ID	VT	IA	WV	MT	NH	KS	SC	NE	SD	KY	WY
		State													
Please enter the date (MM/DD/YYYY).		07/12/ 2012	07/17/ 2012	07/17/ 2012	07/31/ 2012	07/31/ 2012	08/01/ 2012	08/03/ 2012	08/06/ 2012	08/09/ 2012	08/16/ 2012	08/24/ 2012	08/28/ 2012	08/29/ 2012	8/29/ 2012
1. Does your agency collect data on any of the following?	Number of rural crashes	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Cause of rural crashes	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Rural crash fatality rates	X	X	X	X	X	X	X	X	X	X	X	X		X
	Number of emergency medical responses to rural crashes						X								X
	Ambulance or rescue unit response times						X								X
	Patient outcomes									X					
	Emergency or trauma related patient transfers														
	Costs or cost-effectiveness of crash-related emergency medical care	X													
2. Does your department co-locate maintenance dispatch functions with emergency response dispatch?	All												X		X
	Some (please specify approximate percent)						20%								
	None	X	X	X	X	X		X	X	X	X	X			
3. Does your department use communication systems that interoperate directly with emergency response?	Yes/No	Yes	No	No	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes
4. How does your department communicate with emergency responders from different agencies or jurisdictions (check all that apply)?	Through an interoperable radio system	X		X		X	X	X			X			X	X
	Through a system of "patched" or interconnected radio systems				X	X							X	X	
	Instant, text or e-mail messages				X		X							X	X
	Cell phones				X		X	X			X			X	X
	Other (please describe):			State Comm. Patrol			Integrated thru 911		TMC	DOT and EMS…					landline

		State													
Question		MS	AR	ID	VT	IA	WV	MT	NH	KS	SC	NE	SD	KY	WY
5. Does your department provide real-time roadway condition information?	Yes/No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. If real-time information is provided, how is it made available?	511 telephone service			X	X	X	X	X		X	X	X	X	X	X
	Web-based information service	X		X	X	X	X	X		X	X	X	X	X	X
	Dedicated mobile applications			X		X	X						x	X	
	Dedicated hotline for EMS														
	Voice radio system broadcasts				X			X							X
	Other (please specify):			Highway Advisory Radio Broadcast					Twitter						HAR DMS
7. How do emergency responders from different agencies or jurisdictions typically communicate in rural areas (check all that apply)?	Through an interoperable radio system	X		X		X	X	X						X	X
	Through a system of “patched” or interconnected radio systems				X	X						X	X	X	X
	Instant, text or e-mail messages			X	X							X			X
	Cell phones			X	X		X	X				X		X	X
	Other (please describe):			State Comm. Patrol					Don’t know	EMS has both…					
8. Does your department participate in an on-going effort to improve rural crash response or care?	Yes/No	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
9. Does your state use the FHWA *Traffic Incident Management Handbook* for training and procedure development?	Yes/No	No	No	Yes		Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes

		State													
Question		MS	AR	ID	VT	IA	WV	MT	NH	KS	SC	NE	SD	KY	WY
10. Have you implemented strategies outlined in the National Unified Goal for traffic incident management?	Yes/No	No	No	Yes		Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
11. Do department maintenance staffs regularly assist with rural crash response?	Yes/No	No	No	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
12. If staff assists with response, do they commonly perform?	Traffic control	X		X	X	X	X	X	X	X		X		X	X
	Crash site management assistance			X										X	X
	Traffic control device/roadway & bridge repair when needed			X	X	X	X	X		X	X	X		X	X
	Other (please describe)									Traffic control…			Snow plow roads		Clean up
13. Is your department engaged in using, developing or testing new practices in any of the following areas (check all that apply)?	Real-time road/weather data	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Vehicle telematics (such as vehicle location, traffic signal pre-emption, etc.)	X		X	X	X	X	X				X			X
	Incident detection			X			X	X				X			X
	Incident severity determination			X			X	X							
	Training or recruitment practices	X			X		X				X				
	Funding or budgeting	X		X	X		X								
	Crash scene safety			X		X	X	X						X	
	Crash scene clearing			X			X	X				X		X	
	Other (please describe)									KDOT provides					Wyo-Link E-Spotter
14. Would you be available to provide additional information through a follow-up interview?	Yes/No	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes

APPENDIX C

EMS Interview Guide

NCHRP 43-15 Models for Effective EMS Response to Motor Vehicle Crashes in Rural Areas
EMS Interview Guide

1. Describe any efforts/programs specifically aimed at reducing EMS crash response times. Potential topics include:
   a. Crash detection/locating/reporting (i.e. Automatic Crash Notification, E911, NG911)
   b. Expediting dispatch
   c. Improved responder guidance, indicate:
      i. Dispatcher provides guidance
      ii. Dispatch software provides guidance
      iii. In-vehicle devices
      iv. Other
   d. Expediting on-scene time
   e. Improved responder stationing

   Have these reductions been quantified?

2. Describe any methods that are used to check road closures, traffic congestion or weather events that may impact response. Who performs these checks? How is the information relayed to responders?

3. Describe if vehicle or equipment conditions have affected crash response times.

4. Describe any novel practices your agency uses or is planning to use to enhance rural EMS crash response. Possible topic areas include:
   a. Triage/incident severity prediction determination
   b. Vehicle technologies (i.e. Automatic Vehicle Location, Traffic Signal Preemption)
   c. Communication systems
   d. Air transport
   e. Telemedicine
   f. Patient outcome metrics
   g. Record linkages
   h. Recruiting programs
   i. Training programs
   j. Funding or budgeting
   k. Key partnering agencies (i.e. Traffic Management Centers)
   l. Other

5. Is data available on any of the practices identified in question 5? In particular, are performance measures/metrics available? Cost data?

6. Can you provide information on EMS response practices in tribal areas? Do they differ from practices in other parts of your state?

Thank you for participating in this important study.

Erik Minge, Principal Investigator
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APPENDIX D

DOT Interview Guide

NCHRP 43-15 Models for Effective EMS Response to Motor Vehicle Crashes in Rural Areas
DOT Interview Guide

1. Describe any methods the DOT uses to share road closures, traffic congestion or weather events that may impact response with EMS agencies. How is the information relayed to responders?

2. Describe any novel practices the DOT uses or is planning to use to enhance rural EMS crash response. Possible topic areas include:
    a. Reducing EMS crash response times
    b. Expediting on-scene time (incident management guidelines)
    c. Communication systems
    d. Air transport
    e. Record linkages
    f. Recruiting programs
    g. Training programs
    h. Funding or budgeting
    i. Key partnering agencies (i.e. state EMS office)
    j. Other

3. Is data available on any of the practices identified in question 2? In particular, are performance measures/metrics available? Cost data?

4. Can you provide information on EMS response practices in tribal areas? Do they differ from practices in other parts of your state?

Thank you for participating in this important study.

Erik Minge, Principal Investigator
SRF Consulting Group, Inc.
(763) 249-6739

Abbreviations used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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