

# SPECIAL CONTRIBUTIONS

## THE NATIONAL EMS RESEARCH STRATEGIC PLAN

Michael R. Sayre, MD, Lynn J. White, MS, Lawrence H. Brown, EMT-P, Susan D. McHenry, MS,  
for the National EMS Research Strategic Plan Writing Team

### ABSTRACT

One of the eight major recommendations put forth by the National EMS Research Agenda Implementation Project in 2002 was the development of an emergency medical services (EMS) research strategic plan. Using a modified Delphi technique along with a consensus conference approach, a strategic plan for EMS research was created. The plan includes recommendations for concentrating efforts by EMS researchers, policy makers, and funding resources with the ultimate goal of improving clinical outcomes. Clinical issues targeted for additional research efforts include evaluation and treatment of patients with asthma, acute cardiac ischemia, circulatory shock, major injury, pain, acute stroke, and traumatic brain injury. The plan calls for developing, evaluating, and validating improved measurement tools and techniques. Additional research to improve the education of EMS personnel as well as system design and operation is also suggested. Implementation of the EMS research strategic plan will improve both the delivery of services and the care of individuals who access the emergency medical system. **Keywords:** cardiovascular diseases; consensus development conferences; emergency medical services; emergency medical technicians; emergency medicine; health policy; needs assessment; research; resuscitation; United States; wounds and injuries.

PREHOSPITAL EMERGENCY CARE 2005;9:255-266

### INTRODUCTION

The National EMS Research Agenda, published in 2002, was the culmination of a focused multidisciplinary ef-

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Received March 17, 2005, from the Department of Emergency Medicine, The Ohio State University (MRS, LJW), Columbus Ohio; the Department of Emergency Medicine, Upstate Medical University (LHB) Syracuse, New York; and the National Highway Traffic Safety Administration (SDMcH), Washington, DC. Accepted for publication March 18, 2005.

Supported by grants from the National Highway Traffic Safety Administration and the Maternal and Child Health Bureau (DTNH22-99-H-05100).

Address correspondence and reprint requests to: Michael R. Sayre, MD, Department of Emergency Medicine, The Ohio State University, 150 Means Hall, 1654 Upham Drive, Columbus, OH 43220. e-mail: <sayre.84@osu.edu>.

doi:10.1080/10903120590962238

fort to appraise future research needs within the domain of emergency medical services (EMS).<sup>1</sup> Twenty writing team members collaborated to create the document with input from representatives of more than 25 organizations. Several hundred professionals with interest in EMS provided peer review, evaluating and commenting on the document prior to its publication.

The final recommendations of the National EMS Research Agenda were disseminated during an Implementation Symposium held in June 2002.<sup>2</sup> The symposium was specifically designed to engender discussion regarding strategies for implementation of each recommendation.

### A Research Strategic Plan for EMS

The concept of prioritizing EMS research topics arose during the development of the EMS Research Agenda. The implementation symposium participants agreed that an EMS research plan would be useful in several ways:

- The consensus process involved in developing a strategic plan for EMS research could encourage individual agencies to develop common goals for EMS research.
- Prioritization of research topics could be useful to agencies and organizations that provide grants or other funding opportunities.
- Provision of a list of topics of interest to the community of EMS could serve to direct beginning researchers to areas of broader interest.
- Creating and promoting a common agenda could create a unity of purpose within the field of EMS and among individuals, organizations, and agencies with the goal of fostering EMS research.

### Efforts to Prioritize EMS Research

In the past, similar efforts to focus EMS research resources and activities have been undertaken by the

Institute of Medicine,<sup>3</sup> the EMS Outcomes Project (EMSOP) researchers,<sup>4</sup> and the National EMS for Children (EMSC) Resource Alliance.<sup>5</sup> With the exception of EMSOP, which evaluated and ranked EMS conditions for both children and adults, each of these former efforts has been geared toward defining priorities for research within the pediatric population.

### Developing the Strategic Plan

The EMS Research Strategic Plan, commissioned by the National Highway Traffic Safety Administration and the Maternal and Child Health Bureau, was begun by using a Delphi technique to create a list of research topics with broad appeal and support throughout the EMS community.<sup>6</sup> An initial list of 94 topics was subjected to an iterative process that resulted in a ranked list of items. EMS providers, administrators, policymakers, and researchers participated in the structured consensus process. Top-ranking items were grouped, and the rationale for their inclusion was described. The final list of topics was reviewed and revised during a consensus conference attended by representatives of the EMS community and federal partners in March 2005, with the goal of producing a document that could be used to guide the allocation of research-related resources. Appendix A lists the members of the National EMS Research Strategic Plan Writing Team.

### Overarching Issues and Populations

Research into many issues within EMS is long overdue. The topics identified in this strategic plan are considered core items that will benefit from timely investigation. The priorities listed in this document do not include all areas within EMS in need of research. Many other issues such as EMS-based injury prevention programs, reimbursement policies, and scope of practice roles are important, and they should be considered once the core issues have been explored.

Most of the priorities discussed in this strategic plan are not population-specific; they are generally applicable to most populations, including special populations such as pediatric and geriatric patients. The topics are grouped into clinical and EMS system categories, and they follow in alphabetical order (Table 1).

TABLE 1. Priority Topics within EMS Research

Clinical Issues	System Issues and Medical Science
Airway and breathing	EMS provider education
Cardiovascular disease and stroke	EMS system design and operation
General medical	Improving global outcomes
Pediatrics	Research and evaluation methods
Trauma	

## CLINICAL ISSUES

### Airway and Breathing

#### Evaluate Airway Management, Oxygenation, and Ventilation Strategies

Prehospital airway management strategies largely have been extrapolated from the in-hospital setting without rigorous evaluation. Research within the last several years, including an examination of endotracheal intubation of pediatric patients<sup>7</sup> and evaluations of endotracheal intubation in head-injured patients,<sup>8,9</sup> casts doubt on this approach. Effective prehospital airway, oxygenation, and ventilation strategies should be determined.

#### Develop Strategies for Management of Acute Respiratory Distress

The Ontario Prehospital Advanced Life Support (OPALS) group demonstrated that paramedic-level care of the patient with shortness of breath is associated with improved survival to hospital discharge.<sup>10</sup> EMS personnel care for many patients with shortness of breath due to a variety of etiologies such as asthma, exacerbations of chronic obstructive pulmonary disease (COPD), and congestive heart failure. Interventions used in the prehospital environment include continuous positive airway pressure (CPAP) treatment for congestive heart failure or other causes of acute shortness of breath,<sup>11</sup> sublingual nitroglycerin, and aerosolized bronchodilators.<sup>12</sup> Research is needed to evaluate these and other interventions, and to improve the ability of EMS personnel to assess and treat patients with acute respiratory distress.

#### Develop Strategies for Management of Acute Asthma Exacerbation

Since the prevalence of asthma has increased substantially in recent decades,<sup>13</sup> EMS services are caring for more patients with acute exacerbations of asthma.<sup>14,15</sup> Further study is required to determine optimal management of these patients.

### Cardiovascular Disease and Stroke

#### Develop Effective Techniques for Treating Acute Stroke

Stroke is the leading cause of disability among adults in the United States.<sup>16</sup> Because the brain is extremely sensitive to ischemic insult, the time window for treating stroke is narrow.<sup>17</sup> There is currently no effective treatment of reperfusion injury,<sup>18-26</sup> but many investigators believe that combinations of agents may provide therapeutic benefit.<sup>27</sup> Most patients with acute stroke are

transported to the hospital by EMS,<sup>28</sup> and paramedics are capable of identifying acute stroke.<sup>29,30</sup> Research is needed to evaluate the effectiveness of stroke therapy administered in the prehospital setting, as earlier administration may improve outcome.<sup>31</sup>

### **Develop Strategies for Management of Acute Cardiac Ischemia**

Given that patients with chest pain constitute one of the largest subsets of EMS patients, it is important to determine which prehospital treatments are effective. Paramedic services have been shown to reduce mortality of patients with acute myocardial infarction and other causes of chest pain.<sup>32</sup> On the other hand, there is concern about the safety of some treatments for acute cardiac ischemia provided by prehospital personnel.<sup>33,34</sup> Large trials will be necessary to distinguish effective from ineffective treatments.

### **Evaluate Destination Decisions for Patients with Acute Myocardial Infarction**

Treating patients with acute myocardial infarction with percutaneous coronary intervention (PCI) therapy rather than giving intravenous fibrinolytic agents is associated with improved survival.<sup>35</sup> A strategy of preferential transport of patients with acute myocardial infarction to hospitals with immediate PCI treatment capability appears to improve outcome,<sup>35,36</sup> much as organized trauma systems do for patients with major injury.<sup>37</sup> A critical element of the destination decision-making process is to understand the effects that this strategy, with its impact on unit locations and transport times, would have on the patients' outcomes and the health care system.

### **Develop Improved Strategies for Treatment of Nontraumatic Cardiac Arrest**

Provision of rapid treatment for sudden cardiac arrest has been one of the primary reasons for the development of EMS systems.<sup>38</sup> Despite 40 years of sophisticated prehospital care, survival from sudden cardiac arrest in adults remains uncommon, except in a few cities with highly effective EMS systems and in other specialized locations.<sup>39–41</sup> Survival among children with sudden cardiac arrest is even less frequent.<sup>42</sup> Research is needed to evaluate the effect of new resuscitation strategies such as new cardiopulmonary resuscitation (CPR) techniques,<sup>43</sup> faster access to defibrillation,<sup>44</sup> better drug treatments,<sup>39</sup> and initiating hypothermia prior to hospital arrival.<sup>45</sup>

### **Determine the Effectiveness of Mild Therapeutic Hypothermia to Mitigate Neurologic Damage**

Induction of mild hypothermia in the hospital is an effective treatment for comatose survivors of prehospi-

tal cardiac arrest from ventricular fibrillation.<sup>46</sup> Other research shows a positive effect from this treatment for acute stroke.<sup>47</sup> Hypothermia treatment has been shown to be time-sensitive and more effective if started earlier.<sup>48</sup> Intravenous administration of a large volume of ice-cold saline is an effective technique for initiating hypothermia treatment prior to hospital arrival for comatose survivors of prehospital cardiac arrest.<sup>45,49</sup> Prehospital techniques for rapid induction of hypothermia and the benefits of this intervention should be explored.

### **Encourage Early Notification of EMS for Patients with Acute Myocardial Infarction**

Patients with chest pain frequently delay seeking medical treatment. Since the effectiveness of reperfusion therapy for acute myocardial infarction (AMI) is time-dependent, patient survival would improve with earlier EMS access and more rapid hospital arrival.<sup>50</sup> Previous efforts to change the behavior of patients with AMI have not been successful.<sup>50</sup> New strategies are needed to encourage and facilitate earlier access of the EMS system.<sup>51</sup>

## **General Medical**

### **Develop Effective Strategies for Recognition and Management of Shock**

The signs and symptoms of shock can be subtle.<sup>52</sup> Strategies, such as improved assessment techniques and technologic innovations, must be developed to improve the recognition of shock by EMS personnel.<sup>53</sup> EMS-specific management pathways, including those targeting airway management and ventilation, hypertonic saline,<sup>54</sup> medication<sup>55</sup> and blood product administration,<sup>56</sup> and the use of permissive hypotension,<sup>57</sup> must be developed and evaluated for both adult and pediatric populations.

### **Develop Strategies for Identification and Management of Pain**

Pain is a frequent symptom among patients accessing the EMS system. The recognition and management of pain in the EMS setting need to be improved.<sup>58–60</sup> Assessment tools designed to accurately identify and quantify pain are needed for all patients, including those with limited cognitive or language abilities.

### **Develop Strategies for Management of End-of-life Issues**

Caring for patients at the end of life is an important responsibility of EMS personnel. The approach of the EMS system, the perceptions of EMS personnel, and the expectations of patients and family members may

be discordant. Few EMS agencies have established palliative care protocols.<sup>61</sup> Research is needed to define the appropriate role of EMS in these situations, to evaluate various approaches to EMS end-of-life care, and to develop strategies for better preparing EMS personnel, patients, parents, and family members for these sensitive interactions.

## **Pediatrics**

### **Evaluate EMS Systems' Readiness to Care for Pediatric Patients**

Children with severe emergency conditions are relatively uncommon, and consequently most EMS providers have little pediatric clinical experience.<sup>62,63</sup> Studies in the 1990s demonstrated that many EMS systems were poorly equipped and poorly trained to care for children with emergencies.<sup>64-67</sup> The Department of Health and Human Services EMSC program has been working to improve the spectrum of emergency care for children.<sup>68</sup> These efforts have improved training and equipment for EMS personnel. Development and evaluation of evidence-based strategies are needed to enhance the readiness of EMS personnel and systems to care for children.

### **Develop Strategies for Treatment of Pediatric Seizures**

Seizures in children are a frequent reason for EMS use. Many pediatric seizures are relatively benign, while some may be serious or even life-threatening.<sup>69</sup> Improved evaluation techniques and diagnostic tools would be useful in helping EMS providers determine which children need immediate intervention and could prevent potentially harmful overtreatment.<sup>70,71</sup> Optimal therapies for those children requiring prehospital intervention need to be determined.

## **Trauma**

### **Develop Strategies for Management of Major Injury**

Injury remains a leading cause of death in the United States. Current prehospital treatments have not been shown to improve the outcomes of patients with major injury.<sup>72</sup> Innovative prehospital therapies should be developed and tested. The duration of hemorrhage prior to operative intervention is related to survival, suggesting the potential usefulness of automated crash notification systems to summon EMS.<sup>73,74</sup> Advanced EMS diagnostic tools and updated triage algorithms could help EMS personnel determine which patients should be routed directly to a trauma center for definitive care.

### **Develop Effective Prehospital Treatment of Hemorrhagic Shock**

Hemorrhagic shock is a major cause of mortality for patients with major injury. Use of traditional

prehospital treatments may actually be associated with worse outcomes for patients with penetrating injuries.<sup>75,76</sup> For blunt injury, the effectiveness of current prehospital treatments is unknown.<sup>77</sup> New treatments that have promise include hemostatic agents or dressings,<sup>78</sup> blood substitutes,<sup>79,80</sup> newer recombinant clotting factors,<sup>56,81</sup> vasopressin administration to improve vital organ perfusion,<sup>82</sup> and permissive or induced mild hypothermia therapy.<sup>83-85</sup>

### **Develop Strategies for Management of Traumatic Brain Injury**

Traumatic brain injury can result in devastating physical, emotional, social, and economic costs. Neurons are sensitive to the effects of ischemia and reperfusion injury, and immediate intervention may provide optimal benefit. Several areas of study offer potential outcome improvement: the effectiveness of mild therapeutic hypothermia to mitigate focal or global neurologic damage,<sup>86</sup> innovative interventions to prevent lethal brain swelling,<sup>87</sup> and neuroprotective agents such as those currently being evaluated for use in stroke patients.<sup>88,89</sup>

### **Evaluate Airway Management and Ventilation Strategies for Patients with Acute Traumatic Brain Injury**

Evidence is needed to ascertain optimal airway management and ventilation practices for patients with acute traumatic brain injury.<sup>90-92</sup> Data from 2001-2003 challenge whether endotracheal intubation with manual or mechanical ventilation improves outcome in brain-injured patients.<sup>8,93</sup> Further work is needed to explain these findings and the roles of transient hypoxia,<sup>94</sup> hyperventilation,<sup>95</sup> and co-existing hypovolemia.<sup>96</sup> Understanding early physiologic adaptations to brain injury is necessary to determine the most effective airway management and ventilation strategies for such patients.

### **Evaluate the Appropriate Role of Spinal Immobilization**

For many years, EMS personnel have been immobilizing patients with any suspicion for spinal injury.<sup>97</sup> The effectiveness of this practice in reducing the number or severity of spinal cord injuries is in question.<sup>98</sup> There is evidence that backboard immobilization is painful, leads to an increase in costly radiologic studies, and may cause injury to the skin.<sup>99,100</sup> Research is needed to define which patients, if any, need prehospital spinal immobilization.<sup>101</sup> Patient comfort and safety, as well as EMS personnel safety and resource utilization, should be considered in the development of new immobilization strategies.<sup>99</sup>

## SYSTEM ISSUES AND MEDICAL SCIENCE

### EMS Personnel Education

#### Develop Strategies to Improve Education

There are deficiencies in the initial and continuing competence of EMS personnel.<sup>9,102</sup> Research is needed to improve the quality of initial and continuing education to better attain and maintain competency. Educational research methods should identify strategies to increase the efficiency, effectiveness, and quality of EMS education. Pediatric education for EMS providers is of particular interest as providers have few opportunities to care for critically ill or injured children, and EMS personnel have identified pediatrics as requiring additional educational focus.<sup>63,103</sup> Research should also analyze how best to incorporate new technologies (such as advanced human patient simulators and distributed learning) to increase and maintain the knowledge and skills of EMS providers.<sup>104</sup>

#### Assure Entry-Level Professional Competence

While the methods vary, all states are responsible for the evaluation and verification of the entry-level competence of EMS personnel. Research is necessary to assure that the assessments being used are reliable and valid. Additional work should focus on defining and describing the attributes of professional competency in EMS.

#### Assure Continuous Professional Competence

Existing continuing education requirements are not evidence-based; and their effectiveness at maintaining baseline competence, as well as ensuring competence with new or evolving practices, has not been demonstrated.<sup>105</sup> At least one recent report has raised the question of the impact of paramedic experience on the care of critically ill patients.<sup>106</sup> Research is needed to determine the best mechanisms for producing, measuring, and assuring continuing competence, particularly in light of the low frequency of use of critical skills by many EMS personnel and the rapid changes in medical care. Issues to consider include identification of the optimal number of EMS personnel in a system to ensure adequate clinical experience, and how to balance prolonged response times associated with fewer EMS personnel with the increased experience received.<sup>107</sup>

#### Develop Strategies for Improving Critical Thinking and Decision-Making Skills

EMS personnel are required to make critical, time-sensitive decisions with limited information. Decision-making skills can be taught and learned.<sup>108</sup> Examples

from the airline industry and the military may offer strategies that are applicable to similar low-frequency high-acuity events faced by paramedics.<sup>109,110</sup> Research is needed to determine methods for extrapolating these skills to the environment of EMS and to develop proven strategies for ensuring competence in critical decision-making skills of EMS personnel.

### EMS System Design and Operation

#### Evaluate Strategies for Effective Utilization, Deployment, and Configuration

The optimal structure for delivery of prehospital care is unknown. Phase III of the OPALS study demonstrated a positive effect of paramedic-level care on improving survival of cardiac arrest patients to hospital admission but showed little or no effect on survival to hospital discharge.<sup>39</sup> Many have interpreted this to mean that paramedic care is not helpful to cardiac arrest patients.<sup>111</sup> The OPALS study group found that paramedic care had an important positive effect on survival to hospital discharge for patients with chest pain or acute shortness of breath.<sup>10,32</sup> However, in the setting of major trauma, there is evidence that some common advanced life support interventions are associated with a decrease in survival.<sup>8,9,112,113</sup> Research is needed to determine the best methods of configuring and deploying EMS services, including the appropriate distribution of what traditionally have been described as “advanced life support” and “basic life support” personnel.

#### Study Outcomes, Costs, and Cost-Effectiveness of Air Medical Response

Air medical programs are a specific subset of the EMS system that incur substantial costs and particular risks.<sup>114,115</sup> Although research has examined the effects of air medical transport on patient outcome in trauma,<sup>116</sup> stroke,<sup>117</sup> and other conditions,<sup>118</sup> it is possible that the resources used in air transport might produce better outcomes for these patients, or similar outcomes at less cost, if they were used to improve response times and staff skills of surface transport systems. More research is needed to explore health outcomes, to determine the true costs, and to gather cost-effectiveness data for air medical transport for a wide variety of emergencies. Investigations are needed to differentiate the effects on patient outcome resulting from the care of a highly skilled critical care transport crew versus the speed of transport to definitive care.

#### Develop and Validate Medical Necessity Criteria for Dispatch, Transport, and Treatment

EMS systems respond to and transport a large number of patients with minor illness and injuries. A few EMS

systems have explored transporting patients to destinations other than hospital emergency departments (EDs).<sup>113</sup> A number of EMS systems have investigated the use of less costly means of transportation for these patients as well as selective nontransport policies. Others have explored similar triage functions at the level of the 9-1-1 dispatch center.<sup>119-121</sup> It is not known whether such systems reduce costs safely.<sup>122</sup> Additional knowledge is needed to determine how to make these decisions, which patients should be directed to those care pathways, and potential unintended consequences of such initiatives.

### **Evaluate Strategies to Improve EMS Delivery in Rural and Frontier Areas**

Rural and frontier EMS systems face challenges of time, distance, and resources.<sup>123</sup> There are few data to guide the design of EMS systems in remote locations, particularly for patients who require care in specialty medical centers.<sup>124,125</sup> Research is needed that focuses on the methods for delivering timely services in remote locations, and recruiting and maintaining the skills of EMS personnel in rural areas.

### **Validate and Refine Dispatch Protocols**

Some EMS systems provide uniform, immediate response to all calls for assistance, while other emergency dispatch protocols prioritize requests in some way. There has been no sound evidence as to the effect of either approach on patient outcomes.<sup>126,127</sup> There is little evidence to guide EMS systems in structuring response models. Also, with the exception of some work in the area of cardiac arrest and bystander CPR,<sup>128,129</sup> there is a paucity of evidence regarding pre-arrival instructions from the dispatcher to patients or bystanders.

### **Evaluate Models for Integration of EMS into the Overall Health Care System**

EMS is often administered within the public safety infrastructure and outside of the mainstream of health care. Many observers have suggested that improved integration with EMS would be beneficial to public health systems.<sup>130,131</sup> Research is needed to determine the benefits of integration of EMS with public health, which might include improved surveillance for rapidly emerging infectious diseases, improved access to primary care services for patients with limited access due to financial or geographic considerations, more attention to injury and illness prevention, better planning for disasters, enhanced perceptions of professionalism among EMS personnel, and increased efficiencies and decreased costs for the entire health care system.<sup>123,132</sup>

### **Determine Optimal Geographic Location of EMS Resources**

A number of EMS systems have developed extensive plans to position resources for optimal response.<sup>133</sup> Whether implementation of such systems lowers costs or improves patient outcomes is unknown. Systems that do exist tend to be customized for the community in which they were developed and are not easily transportable. Creating a generalizable model system for positioning EMS resources would be useful. Emerging technologies, such as geographic information systems (GIS), may be of value in these efforts.

### **Improving Global Outcomes**

#### **Develop Strategies to Improve Patient Safety and Reduce Errors**

Errors caused by both inpatient and outpatient health care providers pose a significant risk to patients.<sup>134</sup> Although the occurrence and effects of medical errors have not been identified in the EMS setting specifically, it is likely the issue is equally prevalent. Research must be conducted to determine errors in the prehospital setting, as well as to ascertain system processes that are error-prone. Subsequent work should develop and evaluate strategies for reducing errors and increasing patient safety. Well-defined incentives and effective models for quality improvement are needed.

#### **Evaluate Disparities in the Quality of EMS Care**

There is an association between socioeconomic status, race and ethnicity, and the outcomes of many illnesses and injuries, including survival from out-of-hospital cardiac arrest.<sup>135,136</sup> It is unclear whether this is due in part to disparities in the quality of EMS care. Research is needed to identify disparities in EMS care and to determine whether they are related to EMS personnel education and experience, system design and resources, workforce diversity,<sup>137</sup> or the general health and economic status of the population.

#### **Develop Performance-Improvement Methods Based on Valid Measures**

Quality improvement is essential to ensure patient safety and reduce medical errors.<sup>134</sup> Many EMS systems depend on "home-grown" performance-improvement systems or have none at all. Performance measures are often based on EMS system processes not demonstrated to have a relationship with outcomes. There is a need to develop and validate fundamental performance-improvement measures applicable to all EMS settings, with proven measurement tools and techniques that address structure, process, and outcome, and to use those measures in widespread quality-improvement efforts.

### **Evaluate Cost–Effectiveness of EMS**

EMS spans health care, public safety, and public health. It is complex, but possible, to measure cost–effectiveness of EMS services using traditional outcome and cost–effectiveness techniques.<sup>138,139</sup> In addition to measuring cost–effectiveness, the benefits of EMS to individual patients, patient populations, the overall health care system, and society should be studied.

### **Evaluate the Impact of ED Overcrowding and Diversion on EMS Delivery of Care**

Emergency department overcrowding is a serious concern for the health care system.<sup>140</sup> It has reached crisis proportions in many communities and has a direct impact on local EMS.<sup>141</sup> EMS system congestion caused by ED overcrowding could affect overall EMS system performance and diminish the care rendered to individual patients. These effects must be identified and quantified to enable the development and evaluation of mitigating strategies that do not have unintended untoward effects, such as increasing ambulance off-loading times.

### **Evaluate the Impact of Designation of Specialty Care Centers**

The effects of regionalization and designation of specialty care centers on outcomes have not been well studied. Designation and regionalization of specialty care centers for burns, major injury, cardiac care, stroke, and other disease processes requires further analysis to identify and quantify the relative benefits and detriments for patients and EMS systems. Designation and regionalization of resources for specific populations, such as children and the elderly, should be similarly evaluated.

### **Develop Effective Strategies for EMS Responses to Terrorism, Disease Outbreaks, and Other Disasters**

Events that have occurred over the last few years have heightened awareness of the need to be prepared for large-scale catastrophes. Existing strategies for EMS response are largely based on “lessons learned” from previous events.<sup>142,143</sup> Although terrorist attacks and natural disasters do not lend themselves to traditional research methods, there is a need for more formal structured research into the outcomes associated with various levels of EMS response to such events, as well as the effects of such events on the EMS system. Methodologies used in public health and epidemiologic research may be particularly useful in meeting this priority.

## **Research and Evaluation Methods**

### **Identify and Evaluate Outcome Measures**

Extensive efforts have been made to develop scientifically sound and meaningful measures of critical EMS outcomes.<sup>4,144–147</sup> Mortality, while relatively easy to measure, is a rare outcome, requiring large numbers of patients to attribute survival to the performance of EMS alone. Measuring mortality alone fails to address fully the aims of EMS systems, which include ameliorating suffering and reducing disability, as well as saving lives.<sup>148</sup> Outcome measures that can adjust for severity are essential for global monitoring of system performance, for comparison of performance across systems or subsystems, and for trials of effectiveness of elements of practice or validating performance measures. Condition-specific outcome measures may be necessary for individual conditions. Outcome measures alone usually do not lend themselves to quality-improvement efforts, for they frequently lack timeliness or specific information on how to optimize performance. As EMS systems and patient-care practices evolve, measures need to be revisited for appropriateness and validity.

### **Develop Performance Measures Linked to Patient Outcomes**

EMS performance measures typically have focused on process by using indicators such as response times and intravenous success rates, measures that are assumed to be related to clinical outcomes, but have not been demonstrated to have an effect.<sup>149–151</sup> Comprehensive analysis and improvement of performance of complex systems such as EMS rely on evaluating a system’s structure, process, and outcome; they must be demonstrated to be related to one another. Meaningful performance measures linked to a variety of patient outcomes need to be developed, validated, and evaluated for feasibility and usefulness.<sup>4,145</sup>

### **Develop Strategies for Using Medical Information Systems to Improve Patient Care and Lower Costs**

One of the primary challenges to EMS research is determining patient outcomes after arrival to the hospital, a situation made more complex by implementation of the Health Insurance Portability and Accountability Act (HIPAA) regulations in April 2003.<sup>1</sup> The National Highway Traffic Safety Administration (NHTSA) and its partners are developing a National EMS Information System (NEMSIS) to accomplish a number of goals, including enhancing research efforts.<sup>152</sup> The impact of existing regulations on EMS clinical and system research efforts should be delineated and potential solutions evaluated. Effective methods must also be developed for linking EMS information systems,

hospital data, and information from other public safety and service agencies while protecting privacy.

### Identify and Develop Illness and Injury Severity Measures

Existing illness and injury severity indices were developed for predicting or tracking a patient's in-hospital course, and may not be appropriate for prehospital use. Additional research is needed to develop improved severity measures that can be used clinically by EMS personnel, or by researchers and evaluators to adjust for severity in comparing outcomes of care.

### Identify Strategies that Ensure the Ethical Conduct of EMS Research

The difficulty in obtaining informed consent in the prehospital setting represents a unique challenge for EMS research, in terms of both the uncontrolled and often chaotic environment and the compressed time frame in which EMS encounters occur.<sup>1</sup> Although the Food and Drug Administration (FDA) and Office for Human Research Protections (OHRP) have promulgated regulations allowing an exception to informed consent in some emergent situations, few EMS encounters qualify for the exception.<sup>153</sup> Research is needed to identify strategies that facilitate ethical conduct of research without impeding important investigations.

## CONCLUSIONS

New information is urgently needed for many differing clinical conditions, educational methods, and EMS organizational plans. Implementing this strategic plan for advancing research efforts will help EMS improve patient outcomes.

Much work is yet to be done. Large gaps in knowledge are currently being filled by the expert opinions of leaders of EMS systems. Expert opinion not informed by carefully developed scientific evidence is often wrong, and there is no reason to believe that this is any less true in emergency medical systems. Better knowledge is needed to guide the care for emergency medical illness and injury; improved tools and techniques must be developed to enable researchers and clinicians to measure clinically meaningful outcomes and processes; and better educational techniques are required to inform and empower providers to better deliver care to patients. The plan detailed here provides guidance to clinicians, researchers, and EMS system managers as they plan research efforts to answer important questions. Patients will have better health outcomes from the new knowledge to be gained.

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## APPENDIX A. The National EMS Research Strategic Plan Writing Team

Role	Name	Affiliation
Principal investigator	Michael R. Sayre, MD	Ohio State University
Coinvestigators	Lynn J. White, MS	Ohio State University
	Lawrence H. Brown, EMT-P	Upstate Medical University
Writing team members	David C. Cone, MD	Yale University
	Marianne Gausche-Hill, MD	Harbor-UCLA Medical Center
	E. Brooke Lerner, PhD	University of Rochester
	Ronald F. Maio, DO, MS	University of Michigan
	Gregg Margolis, MS, NREMT-P	National Registry of Emergency Medical Technicians
	Edward M. Racht, MD	Austin/Travis County Texas EMS
	Shawn Rogers	Oklahoma Department of Health
	Elinor Walker	Public Representative
Contracting office	Susan D. McHenry, MS	National Highway Traffic Safety Administration
Technical representative		
Administrative staff	Michael Flanagan	National Association of EMS Physicians