CHAPTER

17

Urban EMS Systems

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INTRODUCTION

In 1996 the *EMS Agenda for the Future* projected new roles and responsibilities for EMS to enhance community health care in the 21st century.[1] To accomplish the *Agenda,* three broad strategies were deemed necessary: (1) building bridges between EMS and other components of the community healthcare system, (2) creating infrastructure that supports streamlined public access and rapid delivery of emergency care, and (3) developing new tools and resources. In order to effect these changes, communities would need to integrate health resources (EMS, hospitals, physicians, clinics, etc.) with researchers, legislators, financial experts, human resource personnel, educators, prevention and communication specialists, evaluators, and other key stakeholders. It was predictable that urban EMS medical directors would be critical to the implementation of the *Agenda*.[1–4]

The past decade offers many examples of the enhanced roles of urban EMS medical directors. Hurricanes Katrina and Rita demonstrated the capacity of EMS physicians, including those in New Orleans, Houston, Dallas, Austin, and San Antonio, to guide their communities through large-scale natural disasters. In Massachusetts, the EMS medical director for Boston championed a system for caring for ST-elevation myocardial infarction (STEMI) that is now a model for communities around the world. In fact, there are many examples of urban EMS physicians advancing the *Agenda* in areas ranging from sudden cardiac arrest and stroke to terrorism, pandemic flu, alcoholism, homelessness, asthma, and even emergency department overcrowding. Each success brings urban medical directors greater clinical and political recognition as key advocates for patients and their communities. There has never been a more exciting time for EMS physicians who enjoy the challenge of urban medicine.

BACKGROUND

Although rural EMS often evolved from the efforts of local volunteer organizations, many urban EMS systems arose from hospital-based ambulance services staffed by career personnel. Over the last 30 years, they have developed into a montage of fire department-based systems, private EMS providers, and municipal "third service" models. Among them are permutations that make each unique. Take, for example, the San Diego EMS model, which employs a novel entrepreneurial public-private partnership.

More than 80% of the U.S. population now lives in metropolitan areas, which include cities and their surrounding suburbs.[5] However, the traditional demographic boundaries that once defined urban and suburban continue to blur. Regardless of neighborhood income, geography, population, traffic, or other local variables, urban EMS systems must deliver consistent quality throughout their communities. Citizens and civic leaders now consider timely access to EMS care a right, and a principal role of the urban EMS medical director is to assure that every patient encounter provides high-quality care.

Medical Oversight

Contemporary urban EMS systems require that strong medical directors accomplish their multiple missions as leaders, resources, and patient advocates. Although

urban EMS physicians must have expertise in emergency medicine and prehospital care, they should also possess a firm understanding of the operational components of EMS. They must be closely involved in quality improvement and educational processes within their organizations and communities. They must be familiar with budget policy, payroll, contract, purchasing, inventory, billing and risk management issues, and possess excellent interpersonal skills.

The qualifications for urban medical directors should include significant experience or fellowship training in EMS. When possible, urban medical directors should continue their clinical practices to maintain skills and rapport with physician peers. In urban environments, diverse clinical opinions are common and actively practicing EMS medical directors bring necessary credibility. It is important that employment conditions for urban EMS medical directors provide the freedom to advocate for patients, providers, and the system without fear of retribution.

URBAN SYSTEM DESIGN

It is probably safe to say that the optimal urban EMS system has yet to be designed. Two traditional and several hybrid arrangements are currently employed. The all-ALS (or single-tiered) system places two (or more) paramedics on each ambulance.[6] Tiered EMS systems employ either BLS or ALS ambulance personnel based on the perceived nature of the call. In 2007, 42.7% of urban systems used some form of tiered response, with advanced and basic tiers sometimes working for different agencies.[7] Proponents of tiered systems emphasize that most time-critical, lifesaving interventions, including CPR, defibrillation, and hemorrhage control, can be accomplished by less expensive BLS providers. Tiered systems rely on careful call triage to assign ALS resources to sicker patients, potentially allowing for a smaller, more experienced cadre of paramedics.[6,8]

Increasingly "one-plus-one" (paramedic) system designs are being employed.[7] This design is based on the following facts: (1) most fire department responses today involve calls for medical assistance, (2) there are more fire vehicles than ambulances in urban EMS systems, and (3) fewer than 10% of all 9-1-1 calls require lights-and-sirens transport. Rather than placing two paramedics on each ambulance, the "one-plus-one" system deploys one paramedic-firefighter (with several EMT firefighters) on each fire apparatus and one paramedic (with one EMT) on each ambulance. To make the ambulance EMT a better paramedic partner, some systems provide an EMT "bridge program."[9] One-plus-one systems provide two paramedics at scene for each patient assessment and create enhanced system flexibility. For example, after assessment, stable patients can be transported by the EMT-medic team. This permits the ALS first responder crew to quickly return to service. In addition, since one-plus-one systems place ALS first responders at the scene rapidly, ambulance response time requirements can be relaxed, with significant cost savings.

Ironically, although EMS systems are based on the premise that early ALS care is valuable, this assumption remains to be validated. In one urban setting with short response times, first responder defibrillation (a BLS skill) was the only intervention found to provide a survival benefit for victims of sudden cardiac arrest. Another observational study found the performance of prehospital ALS skills was actually associated with a poorer outcome.[10] Clearly, enhanced survival should not be the only metric by which to judge the value of ALS assessment and care. Given scarce resources, however, it is important for EMS medical directors to recognize that the evidence supporting current practice is often lacking.

URBAN DISPATCH

In urban settings, 9-1-1 calls are automatically routed to public safety answering points (PSAP). At least one third of 9-1-1 calls originate from cellular phones today. Due to the large numbers of cell phones in urban settings, it is common for PSAP call takers to receive multiple simultaneous calls regarding a single incident. In addition, due to incompletely integrated wireless technology, 9-1-1 calls from cell phones and land lines may be routed to different PSAPs. Therefore, urban medical directors must be familiar with each PSAP and secondary call center in their regions, and the operational and clinical implications of these communications issues.

Urban PSAPs are often staffed by law enforcement personnel who initially determine the nature of each emergency. Calls involving medical or fire situations are automatically routed to secondary answering points where further triage and resource assignment occurs. State-of-the-art urban dispatch centers employ automatic vehicle locators (AVL), global

positioning systems (GPS), geographic information systems (GIS), priority dispatch protocols, and computer-aided dispatch (CAD) paging to improve dispatch operations. Sophisticated CAD systems link these technologies to identify and assign appropriate resources and store data on each incident. Currently, more than 66% of urban EMS systems report they can consistently send the closest unit, but this is not uniformly defined by geographic proximity.[7] Unfortunately, separate primary and secondary answering points may not have integrated CAD information systems, making it impossible to accurately determine total call process times. This can seriously hinder the urban EMS medical director's ability to analyze system performance for time-critical conditions such as sudden cardiac arrest. In the future, fully integrated CAD systems may be capable of more precise call processing times and resource assignment based on crash data such as that provided by OnStar.[11]

URBAN RESPONSE

Traditional response time goals for urban EMS systems were derived from models of cardiac arrest, and their relevance to other clinical situations is unsubstantiated.[12] These standards certainly overestimate the acuity of most 9-1-1 medical calls and lend weight to the need for accurate call triage to sort life-threats from non-urgent conditions. Based on these current goals, systems often establish performance metrics for high acuity calls including first responders (4 minutes or less) and ambulance units (8 minutes or less). Rather than average or median times, EMS systems typically employ a 90% fractile response to judge the acceptability of service.[13,14]

First responders are typically held to a "best effort" standard, whereas private ALS ambulance requirements are often defined contractually, with penalties for poor performance. Interestingly, there is little uniformity regarding the start time for such metrics. Some systems "start the clock" on the first ring at their PSAPs (or the secondary answering points), and others begin tracking calls once units are assigned. Communities take into account many factors, including population density, traffic, and barriers to patient access (high-rise, prisons, etc.), when developing their system performance metrics.[15,16]

In 2007 less than half of 9-1-1 medical aid calls in the nation's 200 most populous cities required ALS care.[7] Medically underserved individuals are increasingly turning to 9-1-1 as their entry point to health care. Patients with chronic conditions are more prone to recurrent EMS use.[17] Urban EMS call volumes are increasing, units are getting busier, and urban ambulances are experiencing less downtime. These trends require that the urban EMS medical director understand the basics of system status management in order to guide dispatch policies.[18]

The medical director plays the key role in defining response levels for the system. In communications centers that employ tiered response, the medical director should determine which calls will receive the maximum lights-and-sirens response and which may be safely dispatched with lower acuity and longer response times. Certain low-priority calls can receive BLS assignments with target response times of 30 (or more) minutes. In order for urban EMS medical directors to permit low-acuity responses, their communications centers must have robust quality improvement programs. The EMS medical director must be assured that dispatchers are well trained, that there is high compliance to good protocols, and that outcome data exist to assess performance. Most systems recognize that it makes little economic or medicolegal sense to refuse transportation for nonemergent calls.

Whether rural or urban, ambulance cycle times (dispatch to available status) average approximately 60 minutes. This rate can be translated into staffing schedules based on historical patterns. Rural cycle times typically reflect coverage of more scattered populations with longer travel distances. Urban systems experience variance due to traffic and unpredictable vertical access issues. Furthermore, ambulance shortages increasingly result from both call volume surges and extended emergency department "wall times." Today, many innovative strategies are being employed to improve ALS response times. Paramedic bike teams are routinely employed in Orlando and San Diego at large-scale events. Walt Disney World employs Mobile Ambulance Response Carts (MARC) that can reach all areas of the park within minutes. In many systems, supervisor trucks, cars, and motorcycles provide rapid response. Nontransporting first responders (firefighters, law enforcement, lifeguards) equipped with automated external defibrillators (AED) add another important rapid-response tier in many urban systems. Properly trained police teams have been used to triage and transport victims of sexual assault.[19]

Finally, urban EMS medical directors must define a plan to respond to requests for public assistance within their communities. These calls typically involve

elderly fall victims who require lift assistance. Care must be taken to carefully screen such calls for evidence of injury or serious underlying condition. The urban EMS medical director must assure consistency in handling such "lift assist" calls to protect these fragile individuals while assuring the overall mission of the system. Communities employ a variety of resources on such calls, including law enforcement, no-code fire, and EMS responses.

Assessing the Quality of Care

The urban EMS medical director should play an active, visible role in the design and oversight of the processes responsible for measuring clinical quality. He or she should assure that quality committees exist within the dispatch center, and throughout the operational components of the system. These groups should report to a "quality council" whose members include the leadership of fire operations, ambulance providers, unions, communications centers, and city leadership. The urban EMS medical director should chair this group and define its mission to include the following: (1) fostering continuous quality improvement (CQI) principles throughout the organization, (2) ensuring reward systems exist for CQI participation, (3) communicating achievements of the CQI process, (4) advocating an environment of continuous learning, (5) verifying that key clinical decisions are data-driven, (6) facilitating team performance, and (7) identifying and meeting customer needs.

Continuous quality improvement programs must be proactive, reinforcing positive behaviors while providing education and prompt feedback. All sectors of the system must be included and important aspects of care must be measurable. The urban EMS medical director is responsible for selecting the system performance metrics. Traditional quality indicators include the following: (1) return of spontaneous circulation (or survival) from sudden cardiac arrest, (2) accuracy and consistency of dispatch, (3) successful intubation, (4) use of capnometry to verify advanced airways, (5) scene times in hypotensive penetrating trauma victims, (6) EMS-to-door interval for STEMI patients, (7) off-load delay, and (8) customer satisfaction. Recently, a group of metropolitan area EMS medical directors compiled an evidence-based list of performance measures with the suggestion that systems analyze "bundled" important aspects of the care of key conditions (Table 17.1).[12]

TABLE 17.1

Important Aspects of Care Related to Specific Conditions

Condition	Important Aspect of Care
ST-elevation myocardial infarction	aspirin,12-lead ECG, percutaneous coronary intervention in < 90 minutes
Pulmonary edema	Nitroglycerin, noninvasive positive-pressure ventilation
Asthma	oxygen, beta-agonist medications
Seizure	blood glucose, benzodiazepines
Major trauma	10 min. scene time, transport to trauma center
Sudden cardiac arrest	response interval $<$ 5 min for basic CPR and AED

CONTINUING EDUCATION

The urban EMS medical director is responsible for the content of the continuing medical education of EMS system personnel, and must assure that instructors are prepared and equipped to offer high-quality training. In the past, on-duty personnel were routinely scheduled to attend classroom-based instruction. This approach has been shown to be expensive, and to negatively impact service performance. Newer on-line training and distance learning can be more efficient and appealing. Paramedics, EMTs, and firefighters learn best when instruction is practical and employs interactive learning techniques. EMS systems should investigate new teaching methods including patient simulation and role-playing team scenarios to enhance performance of complex processes such as cardiopulmonary resuscitation. To reduce cost, some systems employ short, focused, modular curricula taught by medical officers to on-duty personnel.

EMPLOYEE SATISFACTION

Employee satisfaction is linked to performance and turnover, and EMS medical directors must monitor both. Stress levels among EMS personnel manifest as somatic and organizational distress and overall

job dissatisfaction. [20-26] The LEADS project surveyed compensation benefits and satisfaction for the National Registry of EMTs. The leading factors associated with job illness and injury were high call volumes and an urban work environment.[25] Other stressors included disordered sleep, exposure to infectious agents, and physical violence. In comparison with the nation's average employee turnover rate (23.4%), EMT turnover was as follows: full-time 15.2%, part-time 23.2%, and volunteer 18.6%.[21] Effective management of stress requires strong employee health and assistance programs. In order to reduce chronic stress and improve clinical experience, some systems rotate crews between slow and busy stations. In fire-based systems, EMT and paramedic crews can also be periodically rotated between ambulances and fire apparatus.

EMPLOYEE SAFETY

Issues of EMS employee health have gained national attention, including a call for a National Center for EMS Provider and Patient Safety.[26] The urban EMS medical director should assure that protocols for occupational exposures are clear.[27] It is important that systems appoint a trained EMS representative to coordinate with hospital infectious control personnel for reporting, source testing, and postexposure prophylaxis. Finally, the urban EMS medical director should provide periodic training updates regarding infectious risks, treatment, and the appropriate means of avoiding exposure.[28-30]

Unfortunately, according to the U.S. Department of Labor, EMS workers experience higher rates of injury than any other industry.[31] The most common conditions are sprains, strains, tears, lacerations, and fractures. Violence exists in EMS,[32] and the medical director should assure that paramedic protocols are adequate for managing severely agitated individuals.

Finally, vehicle crashes contribute to serious workplace injuries, but there is a paucity of ambulance safety standards.[33] During a 5-year period, one statewide study reported moderate and major injuries in 16% and 3% of ambulance-related crashes in their urban setting, respectively.[34] In addition, there was a 1.4% fatality rate among urban EMS providers. In Denver, 91% of ambulance collisions occurred during lights-and-sirens responses.[35] Therefore, urban EMS medical directors must carefully supervise medical dispatch and the use of lights and sirens. Periodic review should be performed to eliminate the inappropriate use of lights and sirens.

AIR MEDICAL

Medical helicopters are used less in urban areas due to shorter transport times.[36] However, dense metropolitan areas occasionally require helicopter transport to overcome geographic access or traffic issues.[37, 38] Recently, air medical transport has been used to address time-critical circumstances including STEMI[39-41] and ischemic stroke.[42, 43] Although there is controversy regarding the value of air transportation in metropolitan areas based on retrospective review of final diagnoses and outcomes,[44] non-clinical factors can sometimes justify medical helicopter use. A 2002 joint position paper from the Air Medical Physician Association and NAEMSP supports the use of air medical services based on medical necessity, patient welfare, and the welfare of the local community.[41] Appropriateness of utilization should be evaluated through CQI programs.

DISASTER PREPAREDNESS

Although disaster planning is no less important in rural settings, multiple casualty incidents and disasters occur more frequently in urban systems. This underscores the importance and opportunity for urban systems to implement standard incident command system (ICS) procedures for all major events.[45] Region-specific disaster plans are essential, and because the spectrum and consequences of urban disasters are more varied, medical directors must coordinate with multiple agencies to develop a range of plans.

In response to the Oklahoma City bombing and the Tokyo Sarin gas attack, in 1996 the Metropolitan Medical Response System (MMRS) was created. Its mission is to help urban areas to plan, train, exercise, and acquire local caches of pharmaceutical and personal protective equipment. The program fosters an integrated approach to medical response planning and operations by employing unified incident management for law, fire, EMS, public health, and other agencies.[46] As a by-product of these strengthened relationships, communities become better prepared for other incidents including hazmat, epidemics, and natural disasters. The urban EMS medical director should be familiar with the process required to activate local, state, and federal disaster resources, including Disaster Medical Assistance Teams (DMAT), urban search and rescue (USAR) task forces, and Metropolitan Medical Strike Teams (MMST).

Finally, EMS system surveillance represents a new tool to detect early evidence of epidemics or bioterrorist threats. The FirstWatch® Real-Time Early Warning System links urban CAD systems to monitor the frequency and clustering of specific dispatch determinants and can trigger alerts if significant statistical irregularity is detected.[47]

EMS AND PUBLIC HEALTH

At the beginning of the 21st century, both EMS and public health share many fundamental healthcare concerns. *Healthy People 2010* defined the health objectives for our nation in the first decade of the new century.[13] It described the public health opportunities all public health systems should strive to accomplish by 2010. Although many of the 467 objectives in 28 focus areas are not germane to EMS, others clearly are, including increasing access to emergency care, public education of early warning signs of heart attack and stroke, and increasing the number of communities using partnerships for substance abuse prevention and treatment. The *EMS Agenda for the Future* envisioned that ". . . the EMS of the future will be community-based health management that is fully integrated with the overall health care system. This new entity will be developed from redistribution of existing health care resources and will be integrated with other health care providers and public health and public safety agencies. It will improve community health and result in more appropriate use of acute health care resources. EMS will remain the public's emergency medical safety net."[1] Urban EMS medical directors and public health officers share common concerns and can contribute to each others' successes.

Today, there are excellent examples of successful partnerships between EMS and public health, including (1) the San Francisco Fire Department Homeless Outreach & Medical Emergency (HOME) Team, which case manages frequent EMS users; (2) the San Diego Serial Inebriate Program (SIP),[48] which significantly reduces transports of chronic homeless alcoholics while promoting sobriety; (3) the Alzheimer Foundation Safe Returns Program,[49] which alerts EMS, fire, and police to rapidly locate and repatriate lost individuals; (4) regional public access defibrillation programs; (5) the CARES Safety Center (Children ARE Safe),[50] a mobile training unit that visits schools; (6) the New York asthma program; (7) carbon monoxide and smoke alarm programs; and (8) the Public Information Education Resource in Memphis. Such interdisciplinary programs arise from effective team-building, a skill that urban EMS medical directors must possess. After all, it is not unusual for a busy urban EMS medical director to interface with law enforcement, fire, hospitals, clinics, attorneys, sheriffs, jails, mental health providers, public defenders, public heath officers, politicians, and patients—all in a single day. This rich experience makes urban EMS medical directors particularly capable of recognizing champions and building powerful coalitions.

SUMMARY

The urban EMS medical director is often more involved in administrative and executive functions than his or her rural counterparts. Higher call volumes, larger systems, and wider variations in personnel, training, patient populations, and call characteristics make the job of the urban EMS medical director unique and challenging. This remarkable mix of experiences and responsibilities provides urban EMS medical directors with valuable perspectives of their communities. Consequently, urban medical directors are able to share their visions by educating citizens, interest groups, and policymakers about EMS within the overall urban healthcare system. Today, the mix of social, political, and economic issues that urban physicians coordinate creates opportunities to address previously unsolvable problems. By building effective teams and staying patient-focused, the urban EMS medical director can be an essential component of the 21st-century healthcare system.

REFERENCES

1. United States Department of Transportation, National Highway Traffic Safety Administration & United States Department of Health & Human Services Public Health Services, Health Resources & Services Administration, Maternal & Child Health Bureau (1996) *Emergency Medical Services Agenda for the Future.*
2. Delbridge TR, Bailey B, Chew JL Jr, Conn AK, Krakeel JJ, Manz D, Miller DR, O'Malley PJ, Ryan SD, Spaite DW, Stewart RD, Suter RE, Wilson EM. EMS agenda for the future: where we are … where we want to be. EMS Agenda for the Future Steering Committee. Ann Emerg Med 1998; 31: 251–263.
3. NHTSA (2000) *EMS Education Agenda for the Future: A Systems Approach* U.S. Department of Transportation/ National Highway Traffic Safety Administration , Washington, DC — DOT HS 809 042.
4. Delbridge TR. EMS . . . agenda for the future. Emerg Med Clin North Am 2002; 20(4): 739–757.
5. Mackun PJ. Population change in metropolitan and micropolitan statistical areas: 1990–2003. U.S. Census Bureau Report September 2005: 1-19.
6. Stout J, Pepe PE, Mosesso VN. All-advanced life support vs. tiered-response ambulance systems. Prehosp Emerg Care 2000; 4(1): 1–6.
7. Williams DM. 2007 JEMS 200 City Survey: is the status quo acceptable? JEMS 2008; 33(2): 48–65.
8. Fitch JJ KR, Williams DM. EMS in critical condition: meeting the challenge. ICMA 2005; 37(5):1-16.
9. Mottet MC. BLS-ALS EMT bridge: one city's unique way to transition BLS EMTs to an ALS system. JEMS 2003; 28(5): 82–90.
10. Callaham M, Madsen CD. Relationship of timeliness of paramedic advanced life support interventions to outcome in out-of-hospital cardiac arrest treated by first responders with defibrillators. Ann Emerg Med 1996; 27(5): 638–648.
11. OnStar Automatic Crash Response. . General Motors website. Available at: http://www.onstar.com/us_english/jsp/plans/acr.jsp . Accessed October 5, 2008. index.jsp.
12. Myers JB, Slovis CM, Eckstein M, et al. Evidence-based performance measures for emergency medical services systems: a model for expanded EMS benchmarking. Prehosp Emerg Care 2008; 12(2): 141–151.
13. U.S. Department of Health and Human Services. *Healthy People 2010: Understanding and Improving Health*. 2nd ed. Washington, DC: U.S. Government Printing Office, November 2000.
14. Kuehl AE, Kerr JT, Thompson JM. Urban emergency medical systems: a consensus. Am J Emerg Med 1984; 2(6): 559–563.
15. Morrison LJ, Angelini MP, Vermeulen MJ, Schwartz B. Measuring the EMS patient access time interval and the impact of responding to high rise buildings. Prehosp Emerg Care 2005; 9(1):14-18.
16. Silverman RA, Galea S. The vertical response time: barriers to ambulance response in an urban area. Acad Emerg Med. 2007. 14(9):772-8.
17. Brokaw J, Olson L, Fullerton L, et al. Repeated ambulance use by patients with acute alcohol intoxication, seizure disorder, and respiratory illness. Am J Emerg Med 1998; 16: 1–4.
18. Tandberg D, Tibbetts J, Sklar DP. Time series forecasts of ambulance run volume. Am J Emerg Med 1998; 16: 232–237.
19. Brands CC, Sing RF, Davidson SJ. Urban trauma transport of assaulted patients using nonmedical personnel. Accad Emerg Med 1995; 2: 486–493.
20. Brown W, Dawson D, Levine R. Compensation, benefits, and satisfaction: the longitudinal emergency medical technician demographic study (LEADS) project. Prehosp Emerg Care 2003; 7: 357–362.
21. Williams DM. JEMS 2007 salary and workplace survey. In a world run on dollars, what about the people? JEMS 2007; 32(10): 42–54.
22. Boudreaux E, Mandry C. Sources of stress among emergency medical technicians (Part I): what does the research say? Prehosp Disaster Med 1996; 11(4): 296–301.
23. Boudreaux E, Mandry C, Brantley PJ. Stress, job satisfaction, coping, and psychological distress among emergency medical technicians. Prehosp Disaster Med 1997; 12(4): 242–249.
24 Brownstone JE, Shatoff DK, Duckro PN. Reducing stress factors in EMS: report of a national survey. Emergency Health Services Review 1983; 2(1): 35–53.
25. Studnek JR, Ferketich A, Crawford JM. On the job illness and injury resulting in lost work time among a national cohort of emergency medical services professionals. J Ind Med 2007; 50(12): 921–931.
26. Paris PM, O'Connor RE. A National Center for EMS Provider and Patient Safety: helping EMS providers help us. Prehosp Emerg Care 2008; 12(1): 92–94.
27. Weidner BL, Gotsch AR, Delmevo CD, et al. Worker health and safety training: assessing impact among responders. Am J Ind Med 1998; 33: 241–246.
28. Roline CE, Crumpecker C, Dunn TM. Can methicillin-resistant Staphylococcus aureus be found in an ambulance fleet? Prehosp Emerg Care 2007; 11(2): 241–244.
29. Lee DJ, Carillo L, Fleming L. Epidemiology of hepatitis B vaccine acceptance among urban paramedics and emergency medical technicians. Am J Infect Control 1997; 25: 421–423.

30. Werman HA, Gwinn R. Seroprevalence of hepatitis B and hepatitis C among rural emergency medical care personnel. Am J Emerg Med 1997; 15: 248–251.
31. Maguire BJ, Hunting KL, Guidotti TL, Smith GS. Occupational injuries among emergency medical services personnel. Prehosp Emerg Care 2005; 9(4): 405–411.
32. Grange JT, Corbett SW. Violence against emergency medical services personnel. Prehosp Emerg Care 2002; 6(2): 186–190.
33. Levick N. Emergency medical services: a unique transportation safety challenge. Objective Safety LLC website. Available at: http://www.objectivesafety.net/2008TRBposterfinal.pdf. Accessed October 8, 2008.
34. Maguire BJ, Hunting KL, Smith GS, Levick NR. Occupational fatalities in emergency medical services: a hidden crisis. Ann Emerg Med 2002; 40(6): 625–632.
35. Custalow CB, Gravitz CS. Emergency medical vehicle collisions and potential for preventive intervention. Prehosp Emerg Care 2004; 8(2): 175–179.
36. Asaeda G, Cherson A, Giordano L, Kusick M. Utilization of air medical transport in a large urban environment: a retrospective analysis. Prehosp Emerg Care 2001; 5(1): 36–39.
37. Thomson DP, Thomas SH. Guidelines for air medical dispatch. Prehosp Emerg Care 2003; 7(2): 265–271.
38. Davis DP, Peay J, Good B, et al. Air medical response to traumatic brain injury: a computer learning algorithm analysis. J Trauma 2008; 64(4): 889–897.
39. Medical condition list and appropriate use of air medical transport. Air Medical J 2003; 22(3): 14–19.
40. Prina LD, Orzai UN, Weber RE. Evaluation of emergency air evacuation of critically ill patients from cruise ships. J Travel Med 2001; 8(6): 285–292.
41. Appropriateness of air medical transport in acute coronary syndromes. Position statement of the Air Medical Physician Association. Prehosp Emerg Care 2002; 6(4): 471.
42. Crocco TJ. Streamlining stroke care: from symptom onset to emergency department. J Emerg Med 2007; 33(3): 255–260.
43. Thomas SH, Kociszewski C, Schwamm LH, Wedel SK. The evolving role of helicopter emergency medical services in the transfer of stroke patients to specialized centers. Prehosp Emerg Care 2002; 6(2): 210–214.
44. Bledsoe BE, Wesley AK, Eckstein M, Dunn TM, O'Keefe MF. Helicopter scene transport of trauma patients with nonlife-threatening injuries: a meta-analysis. J Trauma 2006; 60(6): 1257–1265.
45. National Incident Management System. Department of Homeland Security. Federal Emergency Management Agency website. Available at: http://www.fema.gov/emergency/nims. Accessed June 11, 2008.
46. Metropolitan Medical Response System. Department of Homeland Security. Federal Emergency Management Agency. Available at: http://www.fema.gov/mmrs. Accessed June 11, 2008.
47. FirstWatch real-time early warning system. FirstWatch Solutions website. . Available at: http://www.firstwatch.net. Accessed June 11, 2008.
48. Dunford JV, Castillo EM, Chan TC, Vilke GM, Jenson P, Lindsay SP. Impact of the San Diego Serial Inebriate Program on use of emergency medical resources. Ann Emerg Med 2006; 47(4): 328–336.
49. MedicAlert® + Alzheimer's Association Safe Return® Program. . Alzheimer's Foundation website.Available at: http://www.alz.org/we_can_help_medicalert_safereturn.asp. Accessed June 11, 2008.
50. New Mobile Safety Center Hits the Streets. CARES Mobile Safety Center. Johns Hopkins Bloomberg School of Public Health website. Available at: http://www.jhsph.edu/publichealthnews/press_releases/PR_2004/Gielen_MSC.html Accessed October 5, 2008.