Data Utilization in Emergency Medical Services

JASON RHODES, MPA, AEMT-C; KENNETH WILLIAMS, MD, FACEP, FAEMS

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INTRODUCTION

Emergency Medical Services (EMS) can be defined as a system that provides acute, urgent care and transportation for the sick and injured. EMS practitioners include professionals at many levels, both volunteer and paid, who are trained in the operational and clinical aspects of EMS. Physicians, nurses, respiratory therapists, pilots, dispatchers, managers, educators, maintenance staff, information technology professionals and others all contribute to the EMS system. Increasingly, EMS practitioners also work in other settings where their training is an advantage, such as hospital and other clinical settings, military and law enforcement, preventive and follow-up care systems, safety and security.

These activities generate data of interest to many, ranging from traffic safety scientists and automotive engineers to epidemiologists and economists. This article reviews some EMS data sources and tools available with a focus on using cardiac arrest data to improve system outcomes.

EMS DATA SOURCES

Sources of EMS data can be grouped into three categories:

1] Logistic data, such as time, date and location of events, names of practitioners and services, patient demographics, health insurance information, etc.

2] Clinical data, such as patient assessment, vital signs, treatment and response, etc.

3] Operational data, such as response time, transport distance, communications recordings, practitioner skill logs, quality assurance reviews, patient safety audits, etc.

Much of this data is available from EMS ambulance responses as they are recorded electronically, instead of by prior paper and audio recording tape systems. Electronic recording, dispatch, and patient charting systems have been the long-term industry standard in EMS.–Software vendors offer systems for computer-aided dispatch (CAD), patient charting, quality assurance review, personnel management, GIS mapping of EMS incidents, and other functions. Digital audio recording software now offers transcription and search functions. These advances make EMS data more available for analysis. For most patients, however, outcome data remains separate from the EMS dataset, and requires abstraction or query from hospital databases.

EMS DATA HISTORY

In 1973, state EMS directors realized that there was no standard format or process for gathering and comparing data from one state, one service, one provider, or one patient to another. There was increasing interest in such comparisons as hospital networks and speciality centers developed, ambulances more often crossed state lines, and large ambulance services formed. The emergency medical services system act of 1973 identified 15 essential components of an EMS system, thus creating a rudimentary framework for EMS data collection.[1]

Some systems began extracting data from paper reports or using early scannable paper database systems. Rhode Island had one of the earliest statewide EMS data systems, starting in the 1990s.

The 1990 Utstein style of EMS data reporting for cardiac arrest patients created a more detailed set of EMS data elements and allowed comparison between systems.[2] In 1994, the National Highway Traffic Safety Administration's Office of EMS (NHTSA EMS) developed a national consensus document that defined the first national prehospital EMS data set, with 81 thoroughly defined data elements. This data set formed the foundation for the National EMS Information System, NEMSIS, which was established in 2001. Version 3.5 of the EMS data dictionary is currently in development and encompasses over 500 data elements. The NEMSIS data registry includes data from over 30 million EMS activations submitted by over 10,000 agencies serving 49 states and territories.[1]

While this is an impressive national data set and a unique healthcare enterprise that can answer many research questions, for privacy and efficiency reasons the national data set does not include many elements that are important at state, regional, or individual service, provider, or patient levels. However, similar software is in use at these levels and allows robust local analysis. As is true with any large database where the information is entered without significant oversight, the NEMSIS dataset contains some inaccurate data. However, improvements in data entry rules, physician quality assurance review of EMS charts, and increased understanding of the importance of accurate EMS data should gradually improve data quality. Thus, there is an EMS data pyramid, with a broad base representing individual and local data tapering to a smaller (but still robust) data set at the national level. Topics of particular interest, such as cardiac arrest, highway crash incidents, epidemics, and opiate overdose, merit focused databases.

CARDIAC ARREST DATA AND CARES

For cardiac arrest, independent projects to gather data and benchmark using the Utstein guidelines developed, culminating in the Cardiac Arrest Registry to Advance Survival (CARES) in 2004. CARES was formed through collaboration between the CDC and Emory University's Department of Emergency Medicine. The CARES registry began collecting data in the Atlanta area in 2005 with 600 patients, and has now expanded to statewide data collection in 23 states and 63 community efforts in an additional 18 states, as well as 8 countries outside the US. The registry now includes over 350,000 patients representing the efforts of over 1,400 EMS agencies and 1,800 hospitals.[3] A major use of the CARES registry is benchmarking, as seen in **Figure 1**, with individual agencies able to perform both internal benchmarking against prior performance as well as comparison with like

Figure 1A. Overall Survival Rate Comparison

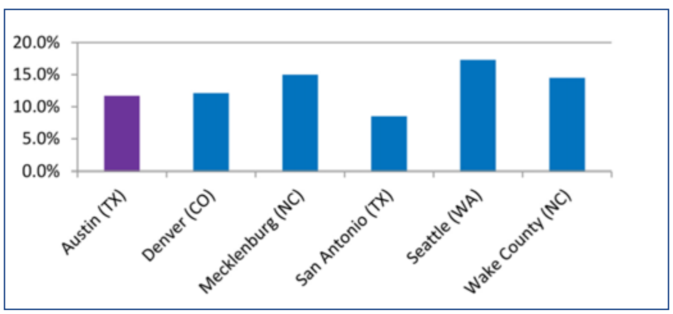
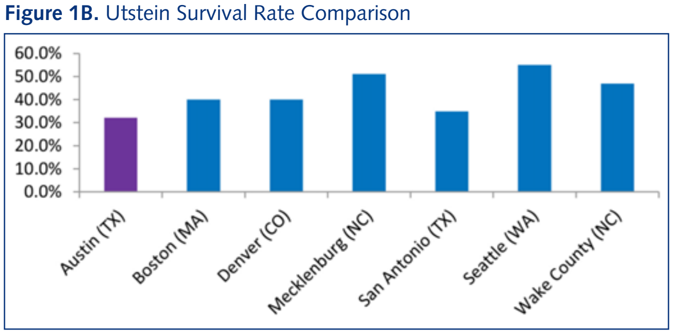


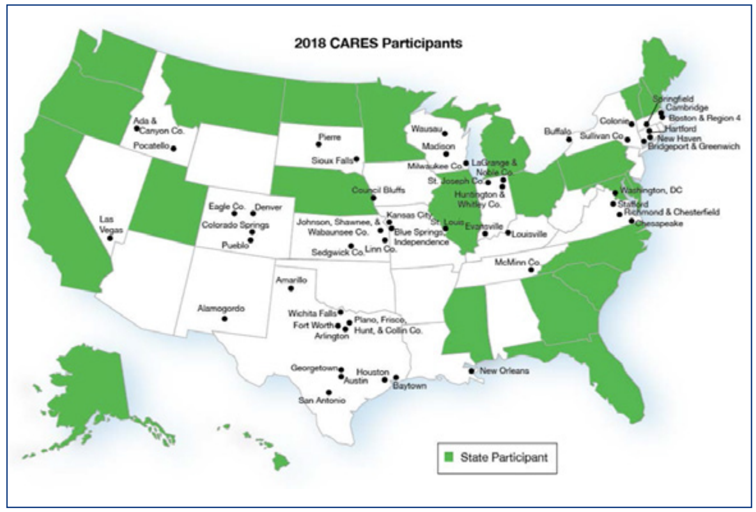
Figure 1B. Utstein Survival Rate Comparison



Source: CARES data obtained from Medical Directors for various EMS providers, June 2013

CARES Survival Rate Comparison, 2012 data
https://mycares.net/sitepages/uploads/2015/CARES%20in%20Action%20Abridged.pdf Accessed Aug. 2018.

Figure 2. CARES Registry Sites



systems or the registry in general. The project also allows discussion of diversity and location information.

Since the NEMSIS database has evolved to include most of the 66 CARES registry elements, barriers to membership have decreased, but abstraction of hospital data still requires significant personnel effort. CARES membership fees present a significant hurdle to many states and agencies, currently including Rhode Island, as shown in **Figure 2**.[4] However, the involvement of focused and dedicated data abstraction personnel also means that the CARES dataset is likely more accurate than the NEMSIS data cube.

In Rhode Island, there is interest in CARES enrollment, currently complicated by lack of funding. However, other efforts are underway including inclusion of CARES elements in the RI EMS data set and efforts to search both traditional data and parse narrative data to develop a strong and accurate statewide EMS database for research and quality purposes.

CASE EXAMPLES

Several hypothetical case examples illustrate the capabilities and utility of EMS data analysis.

Case 1: Individual Patient Data

A 68-year-old male patient has diabetes and congestive heart failure. He lives alone, has poor vision due to diabetic retinopathy. He often has difficulty taking his medication properly but does not qualify for home nursing services. About twice a month, he calls 911 due to symptoms of his chronic diseases, and is often hospitalized. Noting this pattern of readmission, a case management meeting occurred, involving the local EMS agency and their data system. From an analysis of their individual EMS run data, the care team determines that many of his 911 calls have been related to medication errors. With the patient's permission, he is entered into a community paramedicine program where members of the EMS agency visit him at home and assist him with medication dosage and compliance, reducing the need for 911 calls and re-hospitalization.

Case 2: State System Data Improves Cardiac Arrest Care

A state EMS office receives several complaints about questionable resuscitation rates in some communities. In a number of cases during the prior year, patients suffering cardiac arrest in these communities had long waits for EMS care. A query of the prior year's EMS data identifies the set of patients with witnessed and unwitnessed cardiac arrest, and identifies those with bystander CPR, including those who received CPR instructions via 911/Dispatch. After analysis, there does not appear to be discrimination based on cultural or ethnic characteristics, place of residence, responding agency or provider. However, most of the patients in question had their emergency occur during peak call volume times of day, contributing to the prolonged response times. After discussion with several involved providers, the state office determines that low percentages of bystander CPR and dispatcher instruction in CPR via telephone represent a gap in the current system. Focused efforts in both areas begin, and resuscitation rates rise compared with prior year baselines.

Case 3: National Data Reveals Health System Patterns

Syndromic surveillance of EMS data in real time by the National Collaborative for Bio-Preparedness, enabled by BioSpatial, is currently in place.[5] This capability, dependent on prompt uploading of individual EMS system data to state databases and a cooperative agreement between state EMS offices and BioSpatial, monitors a number of syndromes of national interest (cardiac arrest, opiate overdose, motor vehicle crashes, gastrointestinal symptoms, influenza-like illness, etc.). Data at the national level is scrubbed and averaged to avoid privacy concerns, but at the state and service level the system allows access to the original data (at the same level these entities already enjoy). **Figure 3** depicts a year of Rhode Island cardiac arrest data as a heat map – the southernmost portion of the state not visible due to map zoom range.

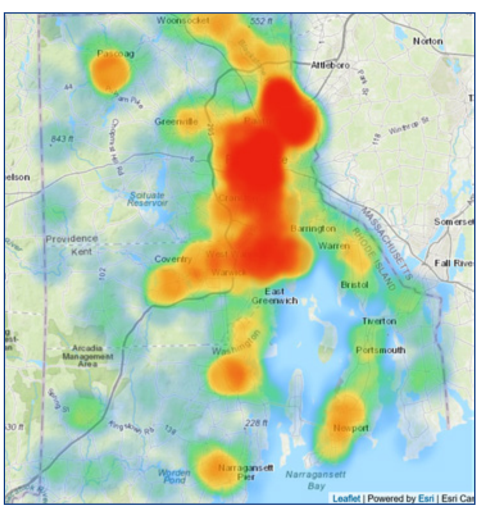


Figure 3. Rhode Island EMS Cardiac Arrest Volume Heat Map (Year prior to 2018 Aug.) Biospatial analysis of RI Department of Health data.

Such EMS data analysis and syndromic surveillance can be used to uncover clusters of foodborne illness and aid in tracking the source, find concentrations of opiate overdose patients to enable community response, and identify the location of accident-prone intersections and segments of highway to facilitate traffic engineering improvements. Surveillance of cardiac arrest data enables identification of neighborhoods at risk due to lack of EMS coverage, AED availability, or low rates of bystander CPR.

SUMMARY

Availability of robust electronic EMS data and tools to share, analyze, and report these data have profound implications for the healthcare system, ranging from ability to improve individual patient disease management to national level syndrome identification and response. Today's data systems and analysis tools, including the NEMSIS Data Cube, the CARES registry, and the National Collaborative for Bio-Preparedness BioSpatial graphic information system analysis and mapping capabilities, provide powerful real-time capabilities for understanding EMS data and improving care across our prehospital system.

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Disclaimer

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Authors

Jason Rhodes, MPA, EMT-C, Chief of the Center for Emergency Medical Services, RI Department of Health.

Kenneth Williams, MD, FACEP, FAEMS, RI Department of Health Center for EMS, Medical Director; Director, Division of EMS, Department of Emergency Medicine,Professor of Emergency Medicine, Alpert Medical School of Brown University.

Correspondence

Kenneth Williams, MD, FACEP, FAEMS
Department of Emergency Medicine
55 Claverick Street, Suite 100, Providence, RI 02903
401-444-5286
kenneth.williams@brownphysicians.org