

Evaluative Measures and Data Collection Methods for Emergency Medical Services Systems

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UNDER THE EMERGENCY Medical Services Systems Act of 1973 (Public Law 93-154) EMS Systems are required to undertake program evaluation activities. The DHEW Program Guidelines (1) specify that:

Each grant recipient... is required to submit as part of a final performance report, an independent review and evaluation of the regional EMS system. It is intended that such review and evaluation be periodic and comprehensive so that changes in emergency health care can be determined... What is required... [is] a review and evaluation of the extent and quality of the service provided. As a minimum the reviewer should have available to him:

- A description of the EMS resources, capability and performance measures at the start of the period being evaluated.
- A description of the interventions brought about during that period to include clinical and EMS component elements.
- A description of the EMS resources, capability and performance measures at the end of the period being evaluated.
- The description of the achievements of performance measures of the EMS system referred to above. There should be at a minimum an analysis of 14 days performance throughout the year. The 14 days should be a modified random sample chosen so that there is at least one day for each month and two replications of each day of the week. Total numbers of calls for ambulance service and of emergency department patient visits should also be reported.

- The report should include a description of the system's resources, capability and performance and also analytical tables to reflect inventory changes, component activity and patient care services.
- Clinical output or impact evaluations of death and disability should include those clinical patient groups that have been specifically addressed in the operations application and include samples of the major categories. General patient population studies as well as specific patient group analysis will have local and national relevance.

We present in this paper a set of evaluative measures and data collection methods for use in evaluating an EMS system. The overriding objective in undertaking EMS evaluation is a determination of change in the capabilities of the EMS system over the grant period. Consequently, it will be necessary initially to develop a set of baseline data indicative of certain performance and capabilities, and then to periodically review these capabilities and performance by reapplying the evaluation methodology.

We selected the evaluative measures with several ends in mind:

- The measures must be responsive to and fully in compliance with DHEW's mandatory program requirement for independent evaluation.
- The measures must allow two types of comparisons: pre- and post-intervention comparisons for the EMS system and comparisons between a particular EMS system and other EMS systems throughout the State and the country.
- Some measures should be universalistic to the extent that they have been and will be applied to all systems while others are uniquely responsive to the particular needs of a given EMS program.
- The measures and their application should force EMS systems managers through several consensus-producing discussions so that evaluative activity will not only generate an agreement on current deficiencies but also on future program directions.
- The measures should exploit, to the fullest extent possible, data likely to be available to local EMS systems.

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Data Sources

When possible, the evaluative measures chosen use available data or data that do not require collection activities. Certain measures identified as essential to evaluation activities are included, regardless of the status of data availability. Much of these data, however, may already have been collected and aggregated; thus, the evaluator needs only to identify their availability and gain access to them. Other data will require aggregation or primary collection. The EMS evaluator will have to develop a plan to obtain such information in order to apply and use it with the evaluative measures.

Data collection methods vary in complexity, cost, time involved, and quality of data produced. Although later in this paper we indicate the preferred method for each evaluative measure, data for some measures can be collected from more than one source. For example, "the proportion of all emergency department patients arriving by ambulance for whom the emergency department received a prior radio warning from the ambulance" could be obtained either by mailing a questionnaire to hospitals and ambulance agencies and asking them to estimate this information or by reviewing emergency department and ambulance records to determine the actual proportion.

The questionnaire-based estimate is likely to be less accurate than the record-based calculation, but it requires less time, resources, and expertise. It is unlikely that each EMS system will have the resources or the willingness to undertake each of the data collection methods each year. Therefore, as a means of determining the relative yield of each method, EMS system managers should note which

measures depend on which of the following methods and particularly which would prevent the development of the evaluation measures if not undertaken.

Hospital survey. A questionnaire is mailed to all hospitals in the service area. Although a courtesy copy should be sent to the hospital administrator, the questionnaire is best sent to the medical director of the emergency department. Few resources are needed, although an effort must be made to follow up nonresponders and to verify independently at least some of the answers. (A more costly variant of this method, but one more likely to provide more reliable data, is an onsite inspection or personal interview.)

Public safety agency survey. Because of the increasingly recognized importance of fire and police agencies (even those not directly providing ambulance service) in often being the first responders to an emergency, they are important resources to be inventoried. Here also, a mail questionnaire is used.

Hospital record abstracts. The medical records or emergency department encounter forms for a particular sampling period (preferably the 14-day method specified in the DHEW Program Guidelines) are abstracted. This costly and time-consuming method requires experts in data processing, medical records administration, sampling, and so on to deal with such issues as: Should all hospitals in the service area be included or only a stratified sample? Should all diagnostic conditions seen at the emergency department during the sampling period be included, or only the high-risk conditions mentioned in the EMSS Act of 1973 (trauma, poisonings, high-risk

infants, acute cardiac condition, psychiatric emergencies, and drug and alcohol overdose)? Should the specified conditions be included if the patients bypass the emergency department by being directly admitted to a critical care unit?

Ambulance record abstracts. As with the hospital record abstracts, the costly and highly complex ambulance record abstracts yield exceptionally important information. This method should include abstracts not only of the ambulance-run reports but also of the associated dispatching, and it must solve the issues of which sampling period, companies, and patients are to be included. Since several methods depend on a linkage of information from both the ambulance and hospital records, the same sampling strategy should be adopted for both.

Users telephone survey. A sample of emergency department patients, preferably stratified so that half arrived by ambulance and half did not, are interviewed by telephone. Although this is a moderately expensive method, the information obtained is not otherwise available. Because of recall problems, the interviews should be completed within 2 weeks after the patients' encounters with the EMS system.

Public telephone survey. Information is obtained from the public within the service area (rather than from users of the EMS facilities) on knowledge, attitudes, and behavior relevant to EMS. The preferred method is to dial random numbers for each telephone exchange in the service area. Because of the bias introduced by the varying times when residents are home, unanswered calls should be repeated during the day, evening, and weekend. This is a moderately expensive method.

Available EMS project data. Although EMS systems vary regarding data available to them, most have access to data on training and vital statistics. Only one special procedure is required for vital statistics—a search of death records for selected patients for a 3-month period following hospital discharge.

Other sources. The final data source suggested is a review panel made up of physicians, emergency medical technicians (EMTs), and nurses, who make certain normative judgments based on ambulance and hospital records submitted to them. Although volunteer labor by panel members makes this method inexpensive, particular attention must be paid to the sampling design and problems of inter-rater and

intra-rater reliability and the validity of their judgments.

Other methods for data collection exist, as do other evaluative measures, and EMS systems managers must be well informed about their relative merits. Nevertheless, the ones we suggest are probably the most cost effective for DHEW's evaluation requirements and for providing a planning and informational basis for an EMS system to take stock of its present status, to plan future goals, and to measure its progress toward achieving these goals.

Evaluative Measures

The following lists of evaluative measures are organized according to EMS components as specified in the EMSS Act. Quotations from the act are given to describe each component, and the data source categories applicable to the particular measures are given in parentheses.

Manpower. "An adequate number of health professionals, allied health professionals, and other health personnel, including ambulance personnel, with appropriate training and experience."

Proportion of fire department personnel who may be first at the scene, but whose primary duties do not include provision of emergency medical care, with cardiopulmonary resuscitation (CPR) training (*ambulance survey*)

Proportion of police department personnel who may be first at the scene, but whose primary duties do not include the provision of emergency medical care, with CPR training (*ambulance survey*)

Proportion of dispatchers with Department of Transportation (DOT) dispatcher curriculum training (*ambulance and public safety agency surveys*)

Proportion of all ambulance personnel with EMT I training (*ambulance survey*)

Proportion of all ambulance personnel with EMT II training (*ambulance survey*)

Proportion of all ambulance personnel without any training (*ambulance survey*)

Number of emergency department registered nurses (RNs) per 1,000 emergency department visits for each hospital (*hospital survey*)

Proportion of emergency department RNs who enrolled in and completed EMT refresher training in the past 12 months (*hospital survey*)

Proportion of ambulance personnel who enrolled in and completed EMT refresher training in the past 12 months (*ambulance survey*)

Proportion of emergency department nurses in each hospital who are trained to function at the nurse practitioner level and do so (*hospital survey*)

Number of critical care unit RNs per critical care bed for each hospital (*hospital survey*)

Number of full-time equivalent emergency department physicians per 1,000 emergency department visits for each hospital (*hospital survey*)

Proportion of emergency department physicians who are members of the American College of Emergency Physicians (*hospital survey*)

Proportion of emergency department RNs who are members of the Emergency Department Nurses Association (*hospital survey*)

Proportion of all physicians in each hospital on call to the emergency department who are board eligible or board certified in their specialties (*hospital survey*)

Proportion of EMS system directors or coordinators who have attended at least one of the following: University of Pennsylvania Center for the Study of Emergency Health Services' EMS training courses, DHEW Conference at Chicago, Grand Rapids, Denver, Los Angeles, or Baltimore (*available EMS project data*)

Training. "The provision for appropriate training (including clinical training) and continuing education programs which (1) are coordinated with other programs in the system's service area which provide similar training and education and (2) emphasize recruitment and necessary training of veterans of the Armed Forces with military training and experience in health care fields and of appropriate public safety personnel in such areas."

Available EMS project data is the data source category applicable to each of the following measures:

Percentage of persons enrolled in EMT I training courses and graduating from those courses in the past 12 months

Percentage of persons enrolled in EMT II training courses and graduating from those courses in the past 12 months

Percentage of persons enrolled in EMT refresher courses and graduating from those courses in the past 12 months

Percentage of nurses enrolled in emergency nurse training courses and graduating from those courses in the past 12 months

Percentage of persons enrolled in DOT dispatcher training courses and graduating from those courses in the past 12 months

Percentage of physicians enrolled in emergency or trauma care physician training courses and graduating from those courses in the past 12 months

Percentage of persons enrolled in first-responder training courses and graduating from those courses in the past 12 months

Number of EMT I courses offered in the past 12 months

Number of EMT II courses offered in the past 12 months

Number of EMT refresher courses offered in the past 12 months

Number of emergency nurse training courses offered in the past 12 months

Number of dispatcher training courses offered in the past 12 months

Number of emergency physician training courses offered in the past 12 months

Number of first-responder training courses offered in the past 12 months

Graduates of EMT I courses as a percentage of all EMTs

Graduates of EMT II courses as a percentage of all EMTs

Graduates of emergency nurse training courses as a percentage of all emergency department nurses

Graduates of dispatcher training courses as a percentage of all dispatchers

Graduates of emergency physician training courses as a percentage of all physicians

Graduates of first-responder training courses as a percentage of all first responders

Percentage of EMT I course graduates who are Armed Forces veterans having service-connected experience in the health care fields

Percentage of EMT II graduates who are Armed Forces veterans having service-connected experience in health care fields

Percentage of EMT refresher-course graduates who are Armed Forces veterans having service-connected experience in health care fields

Percentage of emergency nurse course graduates who are Armed Forces veterans having service-connected experience in health care fields

Percentage of dispatcher training course graduates who are Armed Forces veterans having service-connected experience in health care fields

Percentage of first-responder course graduates who are Armed Forces veterans having service-connected experience in health care fields

Proportion of all EMTs who have taken and passed the National Registry EMT examination.

Communications. "Provisions for linking the personnel, facilities, and equipment of the system by a central communications system so that requests for emergency health care services will be handled by a communications facility which (1) utilizes emergency telephonic screening, (2) utilizes or will utilize the universal emergency telephone number 911, and (3) will have direct communication connections and interconnections with the personnel, facilities, and equipment of the system and with other appropriate emergency services systems."

Proportion of all requests for ambulance aid received through a common access number, such as 911 (*ambulance and public safety agency surveys*)

Proportion of all dispatch points accessible through a common radio frequency (*ambulance and public safety agency surveys*)

Proportion of all ambulance vehicles accessible through a common radio frequency (*ambulance survey*)

Proportion of all hospital emergency departments accessible through a common radio frequency (*hospital survey*)

Proportion of ambulance dispatches from the communitywide central dispatch point (*hospital survey*)

Proportion of all patients arriving by ambulance for whom the emergency department received a prior radio warning from the ambulance (*hospital and ambulance surveys*)

Proportion of all EMS radio equipment operating on the same and appropriate Federal Communications Commission (FCC) frequency (*hospital and ambulance surveys*)

Average (mean) number of minutes between dispatcher's receipt of ambulance request and vehicle leaving for the scene (*ambulance record abstracts*)

Proportion of respondents in random sample of telephone

subscribers who correctly report 911 as the preferred emergency access number (*public telephone survey*).

Transportation. "This component shall include an adequate number of necessary ground, air and water vehicles and other transportation facilities properly equipped to meet the transportation and EMS characteristics of the system area. Such vehicles and facilities must meet appropriate standards relating to location, design, performance, and equipment; and the operators and other personnel for such vehicles and facilities must meet appropriate training and experience requirements."

Proportion of ambulance vehicles in compliance with DOT design specification and American College of Surgeons (2) equipment standards (*ambulance survey*)

Proportion of ambulance runs staffed by at least two EMTs (*ambulance record abstracts*)

Proportion of emergency department patients with a discharge diagnosis of trauma, acute cardiac condition, poisoning, high-risk neonate, psychiatric emergency, or drug or alcohol abuse who arrive at the emergency department by means other than ambulance (*hospital record abstracts*)

Proportion of ambulance-transported, emergency department patients with a discharge diagnosis of myocardial infarction who did not receive cardiac telemetry and protocol-specified stabilization during the prehospital phase (*hospital record and ambulance record abstracts*)

Proportion of ambulance-transported, emergency department patients who received cardiac telemetry during the ambulance phase but who did not have discharge diagnosis of myocardial infarction (*hospital record and ambulance record abstracts*)

Response times (dispatcher receipt of call ambulance, dispatch ambulance arrival at scene, ambulance departure from scene, ambulance arrival at hospital) in minutes, by ambulance company, for trauma, burn, acute coronary, high-risk neonate, psychiatric emergency, and drug or alcohol abuse cases (*ambulance record abstract*)

Response time systemwide for trauma, burns, acute coronary condition, high-risk neonate, psychiatric emergency, and drug or alcohol abuse cases (*ambulance record abstracts*)

Facilities and critical care units. The facilities "component shall include an adequate number of easily accessible emergency medical service facilities which are collectively capable of providing service on a continuous (24 hours a day, 7 days a week) basis, which have appropriate standards relating to capacity, location, personnel, and equipment, and which are coordinated with other health care facilities of the system."

The critical care "component requires providing access including appropriate transportation to specialized critical medical care units. These units should be in the number and variety necessary to meet the

demands of the service area. If there are no such units in the EMS region, then the system will provide access to units in neighboring areas if feasible in terms of time and distance."

In the following measures, horizontal categorization refers to the classification of a hospital's emergency facilities in terms of its general capacity to provide all types of emergency care. Vertical categorization refers to a hospital's specific capacity to provide care for burns, trauma, or cardiac emergency. The classification may be made as a result of a site visit or by the hospital classifying itself by filling out a subjective questionnaire.

Percentage of all hospitals within the region that have been horizontally categorized by means of an onsite inspection (*available EMS project data*)

Percentage of all hospitals within the region that have been horizontally categorized by means of a self-categorization protocol (*available EMS project data*)

Percentage of all hospitals within the region that have been horizontally categorized (*available EMS project data*)

Percentage of all hospitals within the region that have been vertically categorized by means of an onsite inspection (*available EMS project data*)

Proportion of severe burn victims treated at burn units or centers (*hospital record abstracts*)

Proportion of severe multiple trauma victims treated at trauma units or centers (*hospital record abstracts*)

Proportion of patients with suspected spinal cord injuries treated at spinal cord treatment centers (*hospital record abstracts*)

Proportion of alcohol and drug abuse patients treated at detoxification centers (*hospital record abstracts*)

Proportion of high-risk neonates treated at an institution sponsoring high-risk infant centers (*hospital record abstracts*)

Proportion of myocardial infarction patients treated at coronary care units (*hospital record abstracts*)

Proportion of psychiatric emergency patients treated at psychiatric units or centers (*hospital record abstracts*)

Proportion of random sample of emergency department records that, in the judgment of a panel of two emergency department physicians and an emergency department nurse, indicate that the patient was treated in a facility significantly lacking the clinical resources necessary for his or her treatment (*other sources*)

Proportion of hospital facilities that are in compliance with Joint Commission on Accreditation of Hospitals standards (*hospital survey*)

Public safety agencies. "Provisions must be made for effective utilization of appropriate personnel, facilities, and equipment of each public safety agency in the area."

Proportion of public safety agency radios that are frequency-compatible with ambulance-hospital-dispatch frequencies (*hospital, ambulance, and public safety agency surveys*)

Proportion of all non-EMS public safety agency personnel

who have completed any EMS training course (*public safety agency survey*)

Proportion of EMS Council (1) members who are public safety agency representatives (*available EMS project data*)

Average attendance rates of EMS Council members who are public safety agency representatives (*available EMS project data*)

Consumer participation. “The EMS system must make provisions in its system management that persons residing in the area and having no professional training or experience may participate in the policy making for the system.”

Number of EMS Council members who are consumers (*available EMS project data*)

Proportion of EMS Council members who are consumers (*available EMS project data*)

Average attendance rate of consumer members of the EMS Council (*available EMS project data*)

Accessibility to care. “The EMS system must provide necessary emergency services to all patients without prior inquiry as to the ability of the patient to pay.”

Proportion of hospital emergency departments displaying a poster indicating, or otherwise demonstrating, that emergency care will be given without regard to ability to pay (*hospital survey*)

Proportion of service area's population within 10 minutes' travel time of an emergency department by ground transportation (*available EMS project data*)

Proportion of all emergency ambulance transports accounted for by commercial ambulance companies routinely inquiring as to ability to pay before rendering service (*ambulance survey*)

Transfer of patients. “The EMS system shall provide for the transfer of patients to facilities and programs which offer such follow-up care and rehabilitation as is necessary to effect the maximum recovery of the patient.”

Proportion of all intrahospital transfers that were preceded by a physician-to-physician agreement and accompanied by medical records (*hospital record and ambulance record abstracts*)

Proportion of a sample of all intrahospital transfers judged by the review panel (made up of an EMT, an emergency department nurse, and an emergency department physician) to be (a) not clinically indicated, (b) unsafe, or (c) did not receive adequate in-transit monitoring, intervention, or continued stabilization (*other sources*)

Proportion of a sample of hospital medical records of acute cardiac, poisoning, trauma, high-risk neonates, psychiatric emergencies, and drug or alcohol overdose cases that, in the judgment of the review panel, (a) were not referred to a clinically indicated critical care unit or (b) did not receive adequate rehabilitation or followup care, or both (*other sources*)

Standardized patient recordkeeping. “Each EMS regional system shall provide for a standardized patient recordkeeping system which shall cover the treatment of the patient from initial entry into the system through his discharge from it, and shall be consistent with patient records used in follow-up care and rehabilitation of the patient.”

Proportion of all ambulance dispatches that were recorded on a standardized dispatch form (*ambulance survey*)

Proportion of all ambulance transports that were recorded on a standardized ambulance trip report form (*ambulance survey*)

Proportion of all emergency department visits that were recorded on a standardized emergency department record (*hospital survey*)

Proportion of patients for whom the following data are routinely collected: (a) patient identification information—The records must be designed so that the dispatcher record, ambulance record, and emergency department record on each patient can be compared for evaluation and management purposes, (b) how patient arrived at the emergency department, (c) ambulance response time, time at scene, and travel time to hospital, (d) patient condition at scene and on arrival at emergency department, (e) patient treatment at scene and during transport, (f) disposition of patient—discharged, referred for outpatient care, referred to another hospital, admitted, or expired, and (g) condition of patient on discharge from emergency department (*hospital record and ambulance record abstracts*)

Public information and education. “The EMS system shall provide programs of public education and information for all people in the area so they know about the system, how to access it, and how to use it properly.”

Proportion of a telephone sample of recent users of the EMS system who reported satisfaction with ambulance service and proportion reporting satisfaction with hospital emergency department used (*users telephone survey*)

Proportion of a random telephone sample of the public that indicated (a) how to request an ambulance, (b) CPR procedures, (c) nearest hospital emergency department, (d) designated regional facility (or the most appropriate facility) for burn cases, cardiac patients, trauma, high-risk infants, psychiatric emergencies, and drug or alcohol overdose patients, (e) poison center telephone number, and (f) appropriate antidote for commonly ingested poisons (*public telephone survey*)

Independent review and evaluation. “Each EMS system must provide for (1) periodic, comprehensive, and independent review and evaluation of the extent and quality of the emergency health care services provided in the system's service area and (2) submission to the Secretary of the report of each such review and evaluation.”

Number of automobile accidents (*available EMS project data*)

Number of injuries resulting from automobile accidents (available EMS project data)

Number of deaths resulting from automobile accidents (available EMS project data)

Number of deaths per 100 injuries resulting from automobile accidents (available EMS project data)

Death rates, by age groups, due to (a) myocardial infarction, (b) poisoning, (c) trauma, or (d) drug or alcohol overdose (available EMS project data)

Three-month survival rates for patients discharged with a diagnosis of (a) myocardial infarction, (b) poisoning, (c) trauma, or (d) drug or alcohol overdose (available EMS project data)

Three-month survival rates for high-risk neonates (available EMS project data)

Ratio of patients dead on arrival of ambulance at emergency site to patients who died after ambulance arrival but before admission to emergency department among all ambulance transports (hospital record and ambulance record abstracts)

Ratio of dead to live hospital discharge for patients with a primary discharge diagnosis of myocardial infarction, poisoning, trauma, drug or alcohol overdose, or high-risk neonate (hospital record abstracts)

Disaster linkages. "The EMS system must have a plan to assure that the system will be capable of providing emergency medical services in the system's service area during mass casualties, natural disasters or national emergencies."

Proportion of EMS facilities (dispatch points, ambulances, and hospital facilities) with a designated role in an area-wide disaster plan (available EMS project data)

Proportion of EMS facilities taking part in a practical dry-run test of the areawide disaster plan during the previous 12 months (available EMS project data)

Mutual aid agreements. "Each EMS system must provide for the establishment of appropriate arrangements with EMS systems or similar entities serving neighboring areas for the provision of emergency medical services on a reciprocal basis where access to such services would be more appropriate and effective in terms of the services available, time and distance."

Number of written mutual-aid agreements signed by authorized individuals (available EMS project data)

Proportion of such mutual aid-agreements which (a) have been reviewed and reevaluated during the previous 12 months and (b) specify mutual aid, communications linkages, licensure and certification, and reimbursement (available EMS project data)

Discussion

The evaluative measures suggested here vary greatly in their conceptual bases, ease of measurement, and programmatic focus. Thus, some are measures of structure (the availability of resources), some of process (the use of resources), and some refer to out-

comes (changes in health status, such as mortality and morbidity rates).

Each kind of measure has advantages and disadvantages (3). Structure measures are easily completed and cost little—although they assume that the availability of resources means that they will be used advantageously, which is not always so. Process measures also assume (often with little evidence) that use of an EMS resource will be beneficial to outcome. Process measures are also relatively expensive to collect, although they are probably more instructive programmatically than structure and outcome measures in indicating how well EMS systems are doing and what should be done differently. Outcome measures are conceptually the most important because they refer to lives saved or disability averted; however, they often are prohibitively expensive to collect and may tell managers of EMS systems surprisingly little as to what they should do differently. Moreover, outcome measures are difficult to interpret because an outcome measure, such as a death rate, may be a function of factors, such as lower speed limits and safer cars, that are unrelated to EMS systems.

This observation should serve as a reminder of the importance of research design, and that measures in and of themselves can be misleading and invalid if the design is weak. A research design is the way in which comparisons are made and evaluative conclusions drawn. Thus, most of the suggested measures are best for comparing an EMS system with itself at different times. The measures are relatively weak in assessing whether one system is better or more efficient than another. Systems vary greatly in their availability of resources and environmental constraints, and a straight comparison using many of these measures would not take these into account sufficiently. Above all, it is important to see these measures as a menu from which individual EMS system managers must select according to their resources, programmatic goals, and interests. The measures are not substitutes for common sense, and they must be supplemented with adequate research design.

References

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