Guidelines for Research and Evaluation of Emergency Medical Services

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THE EMERGENCY MEDICAL SERVICES Systems Act of 1973 will make available $185 million over a 3-year period to States, counties, cities, and other nonprofit associations to develop or expand comprehensive area emergency medical services. Although most States and many regions have been involved in EMS projects in the past under funding from the Department of Transportation, the Regional Medical Programs Service, and the Comprehensive Health Planning Service, it is apparent that, in awarding grants and contracts under this new program, the Federal Government will place much more emphasis on research and evaluation than it ever has previously. Thus section 1202 of the act (Public Law 93–154) states, "An application for a grant or contract . . . shall demonstrate to the satisfaction of the Secretary the need of the area for which the study and planning will be done for an emergency medical services system." Section 1206, in outlining the minimum set of components for a fundable emergency medical services (EMS) project, states that an EMS system must "provide for 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 submission to the Secretary of the reports of each such review and evaluation."

It is quite clear, therefore, that research and evaluation of emergency medical services is no longer just a desirable byproduct of Federal funding, but instead is a major precondition for initial awards and subsequent renewal. It is equally clear that EMS evaluation and research can, and under the new program will, move beyond the merely descriptive inventorying of resources and "ambulance counting." Research methodologies have been sufficiently developed over the past decade so that it is now possible and essential for programs to justify their need for EMS funds and evaluate the effectiveness of their use through the process and outcome of EMS care, in addition to the traditional resource counting. This paper outlines some of the new methodologies and commends their use by program applicants under the 1973 EMS act.

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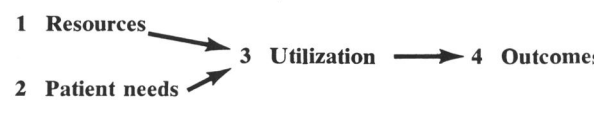
The research and evaluation component of an EMS project typically involves two phases: (*a*) baseline evaluation before implementing training and communication systems and (*b*) ongoing evaluation of the effect of implementation. The first purpose of collecting baseline data is to form an empirical basis for recommendations as to the precise change to be made. The second purpose is to secure a clear picture of the EMS system before intervention so that changes in performance attributable to intervention may be measured and evaluated. The general model for baseline evaluation follows.



Format 1. Hospitals with emergency medical service resources

Hospital type	City hospitals		Suburban hospitals		Total	
	Number	Percent	Number	Percent	Number	Percent
Number of beds						
0–199						
200–399						
400 or more						
Teaching involvement						
No teaching program						
Residency or intern program						
Medical school affiliation						

Although most existing EMS research is concerned only with resources, in this model data must also be collected on patient needs, utilization (or process variables), and outcomes for an adequate evaluation of both pre- and post-intervention performance of the EMS.

Resources Data

Information on existing EMS resources is collected from hospital, ambulance, and communication facilities by means of an onsite evaluation. Mail questionnaire surveys are unsatisfactory because they do not allow the project to be explained in person to leaders of the facility being surveyed and because this method is not likely to produce valid data. Survey forms to evaluate hospital and ambulance facilities are available from the Division of Emergency Health Services (D.E.H.S.), Box 911, Rockville, Md. 20852.

Alternatively, survey forms can be developed from guidelines published by the American Hospital Association (AHA), American Medical Association (AMA), Committee on Trauma of the American College of Surgeons (ACS), Joint Commission on Accreditation of Hospitals (JCAH), and others (*1–5*). For hospital surveys, certain resource data are available from the Guide issue, published as a supplement to the August issue of Hospitals, the Journal of the American Hospital Association, up to August 1971 and as a separate publication each August thereafter.

This publication gives data on the availability of residencies and internships; number of beds, admissions, and intensive care and critical care units; and availability of facilities for X-rays, laboratory tests, premature infants, poison control, and other EMS-related facilities as well as a self-rating of the emergency room category for each hospital in the United States.

The onsite survey of a hospital is concerned with the availability of equipment, supportive services, staffing patterns in the emergency room (ER), backup specialist services, administrative arrangements, clinical procedures, and volume of visits. The D.E.H.S. survey forms can be completed in 2 or 3 hours by having a research assistant (preferably a registered nurse or senior medical student) interview the nurse in charge of the emergency room or the ER physician director, or both, and the hospital administrator. All facilities in the project area must be surveyed, including Veterans Administration and State mental hospitals and private psychiatric facilities. It is also desirable to survey industrial clinic facilities.

Although each facility may not be willing to become or be an appropriate part of the day-to-day EMS system, its resources need to be inventoried for disaster planning or for specialized services, such as detoxification, psychiatric holding, and other services that a facility may be willing to provide.

From these data, measures for evaluating present adequacy and for future planning can be developed to describe hospital emergency medical services in the project area. Five measures are listed.

HOSPITAL RESOURCES MEASURES

1. Percent of hospitals with a physician in the ER at all times

2. Percent of hospitals with laboratory and X-ray facilities staffed at all times

3. Percent of hospitals with necessary equipment in the ER

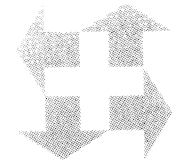
4. Percent of hospitals with needed specialists on call within the hospital at all times

5. Percent of hospitals in compliance with ACS, AHA, and JCAH guidelines for administrative arrangements (ER committee and others), clinical guidance (manual, medical, audit, and so forth), and procedures (for observation beds, for patients with diagnoses of suicide, rape, drug overdose, and alcoholism, and psychiatrically disturbed patients).

To relate this resource information to subareas of the region and to characteristics of the hospitals, it can be displayed using format 1.

These measures of resources allow existing hospital emergency services in the project area to be compared with those reported in the literature for hospitals in other areas and to be categorized, by AHA and AMA definitions, into levels of resources available. These data, with appropriate recommendations from the staff of the research component, should be reviewed by a project committee representative of the community's health structure to determine whether certain resources overlap and would be better coordinated with categorization and whether certain resources are absent and should be secured, either through individual applications for Hill-Burton funding or through the EMS project itself.

Information on ambulance resources is to be similarly collected through onsite completion of survey forms. The D.E.H.S. form can be completed in about 2½ hours and provides information on personnel training, procedures, and costs and on equipment and vehicles. Again, it is essential that all ambulance facilities be surveyed, including commercial, hospital-based ambulances, police and fire department transportation and



first aid activity, and the facilities of volunteer fire companies. If private ambulances are licensed and subject to minimum standards, secondary survey data may be available from the licensing authority—the State, county, or city agency. Four evaluative measures are listed.

AMBULANCE RESOURCES MEASURES

1. Percent of ambulances in compliance with minimum equipment of the ACS list

2. Percent of ambulance staff with emergency medical technician training beyond Red Cross Advanced First Aid certification

3. Percent of ambulances with radios to communicate directly with receiving hospital

4. Number of trained attendants per ambulance.

These data should be reported in a way that allows resource comparisons between subareas and ambulance agencies or by following format 2.

In addition to collecting and reporting information on existing resources, it is essential that measures be derived that indicate the quantity of aggregate community resources available to the population base. Ten measures of EMS resources in relation to population are listed in format 3. These resource-to-population ratios allow comparisons of resource availability between the project region and other areas as well as within the subareas of the region.

The availability of human resources is a function of staffing patterns which vary by shift. Data on four of the resource units in format 3 (1.

Format 2. Ambulances with emergency medical services resources

Ambulance agency	City ambulance		Suburban ambulance		Total	
	Number	Percent	Number	Percent	Number	Percent
Commercial						
Hospital-based						
Police department						
Fire department						
Volunteer fire company						
Independent volunteer						
Total						

Format 3. Ratios of emergency medical services resources per 1,000 population, by location

Resource unit per 1,000 population	City					Suburbs				
	North	East	South	West	Total	North	East	South	West	Total
1. Physicians in ER at all times (day, evening, night)										
2. Laboratory and X-ray facilities staffed at all times										
3. Specialists on call within a hospital										
4. Items of equipment in ER										
5. Beds in intensive care and critical care units										
6. ER treatment cubicles										
7. Observation beds										
8. Complying ambulances										
9. Medical-emergency-technician-trained ambulance personnel										
10. Radio-equipped ambulances to hospital										

Format 4. Emergency services resource availability by shift

Time and location	Resource unit per 1,000 population [1]			
	Item 1	Item 2	Item 3	Item 9
City weekdays:				
8 a.m.–4 p.m.				
4–12 p.m.				
12 p.m.–8 a.m.				
City weekends:				
8 a.m.–4 p.m.				
4–12 p.m.				
12 p.m.–8 a.m.				
Suburbs weekdays:				
8 a.m.–4 p.m.				
4–12 p.m.				
12 p.m.–8 a.m.				
Suburbs weekends:				
8 a.m.–4 p.m.				
4–12 p.m.				
12 p.m.–8 a.m.				

[1] See format 3 for definition of items.

physicians in ER at all times, 2. laboratory and X-ray facilities staffed at all times, 3. specialists on call within a hospital, and 9. medical-emergency-technician-trained ambulance personnel) should be recorded as in format 4.

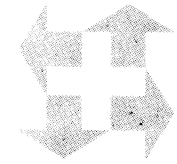
Patient Need Data

Returning to the initial model for baseline evaluation, we see clearly that both baseline and ongoing evaluation depends not only on resource inventories, but also on data to describe existing demand or needs, or both, for these resources. Available guidelines and minimum standards are excellent in evaluating resources in isolation, but they are dangerously inaccurate for evaluating whether resources are adequate to meet actual need and demand in a given community. Unless existing resources are evaluated and future resources allocated on the basis of an empirical estimate of clinical patient needs in a given locale (rather than uncritical compliance with national guidelines), a community and its funding resources run a grave risk of providing either excess or deficient resources to meet actual need. Whether a neurosurgeon should be on call, or X-ray and laboratory facilities staffed around the

clock, and so forth should depend not so much on JCAH or ACS national guidelines as on patient needs in a region.

These data can be secured from several sources. First, data should be abstracted from the emergency department medical records for all patients seen at each hospital ER facility in the area. Since it is impossible and unnecessary to abstract all records, certain periods ought to be sampled. Thus in Erie County, N.Y., we selected four 1-week periods during the year preceding the project and used a computer-readable optical-scan abstract form. We collected clinical and demographic data on all 25,000 visits to 23 of 24 hospital ERs in the county during these four periods. The forms cost $7 per 1,000 from IBM, and our research assistants at $3 per hour completed about 80 forms during an 8-hour shift. Each abstract, therefore, takes 6 minutes and 30 cents (in labor costs) and .07 cent for each form. Since the form is computer readable, there are no added costs for inaccuracies in coding, punching, and verifying the cards.

The second source of data for patient needs is ambulance records. Taking the same four 1-week periods, we abstracted clinical need data from the dispatch and ambulance assistance records in Erie County. Since only 10 percent of all patients require an ambulance, we abstracted 2,500 ambulance case records. In States requiring private and hospital-based ambulances to submit a report on each run to the licensing authority, secondary data may be available. Although patient needs are often equated with patient demand, they differ; patient demand refers to actual use (whether or not the use was clinically justified), while patient need refers to the clinical need for emergency medical services (whether or not they were used).



This distinction indicates the necessity for EMS researchers to estimate need independently of actual use. Specifically, they should examine whether certain categories of events and persons in great need of services actually received them. The three major sources for this information are death certificates with mentions of accidents, homicides, drownings, suicides, cardiovascular accident, myocardial infarct, and drug overdose; automobile accident injury data from police and motor vehicle registration agencies; and calls for medical assistance to 911 or other dispatch systems.

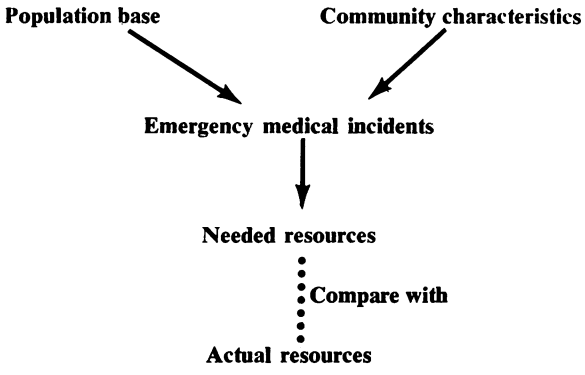
From these sources, information and clinical judgments can be collected to evaluate patient need. Patient needs for emergency medical services may be described and their geographic and temporal distribution reported by using format 5.

From data described with greater clinical detail than the list in format 5, judgments as to resources needed by location and time can be made to provide evaluative comparisons with actual resources. For example, with knowledge of the incidence and distribution of myocardial infarctions, reasonable estimates may be formed of needed resources in terms of ambulances equipped with telemetry, ambulance equipment, and stabilizing procedures and of cardiologists, defibrillators, critical care units, and so forth in the emergency room. These data may also be related to the population base so that reasonably accurate predictions may be made as to the future volume of patient needs as well as the likely impact of population changes, the opening of a freeway, or the categorization of

Format 5. Mean number of medical incidents per 8-hour shift

Incident	City			Suburbs			Total		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
1. Myocardial infarction									
2. Poisoning									
3. Drug overdose									
4. Cardiovascular arrest									
5. Fracture									
6. Head trauma									
7. Severe lacerations									
8. Threatened abortion									
9. Psychotic episode									
10. General illness									

hospital facilities. The causal model may be diagramed as follows:



Resource Utilization

The initial model indicated EMS resources and patient needs as inputs to the EMS system with various outcome states as output. The intermediate stage may be referred to as process or throughput or utilization; that is, the several interactions that take place between resource and need. One interaction sequence is shown in the diagram. By using records of ambulance runs, participant observations, and clinical judgments, the following data can be collected.

AMBULANCE UTILIZATION MEASURES

1. Runs per vehicle per year by type of injury
2. Percent of runs with at least one medical emergency trained technician
3. Runs per 1,000 population per year for each ambulance agency
4. Percent of runs when ambulance informed hospital of impending arrival
5. First aid procedures performed at scene and en route
6. Mean interval between occurrence of incident, arrival of ambulance at scene, departure from scene, and arrival at hospital
7. Percent of dry runs
8. Minutes per day ambulance is in use
9. Runs to each hospital
10. Costs, charges, and income per run.

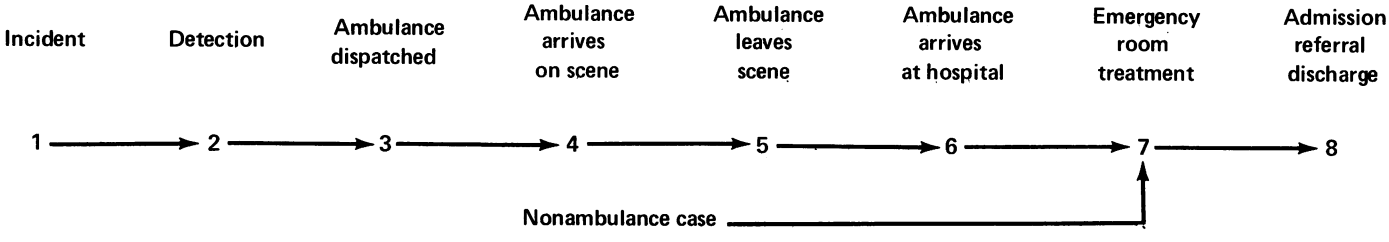
Similarly, data on hospital ER utilization can be collected by abstracting medical records and from interviews and observations of patients at each hospital during a 24-hour period. The following data are needed:

HOSPITAL UTILIZATION MEASURES

1. Visits for each hospital per year
2. Visits (aggregate) per 1,000 population
3. Visits by injury type and severity rating
4. Percent of visits for nonurgent and scheduled procedures
5. Mean interval between arrival of patient and first encounter with physician, intern, or resident and admission or discharge
6. Average length of stay for emergency room admissions
7. Distribution of visits by hour, shift, day of the week, and season
8. Treatment procedures by clinical condition
9. Disposition of patients: admission, referred to outpatient department, referred to private physician, transferred to another hospital, told to return, discharged
10. Distribution of X-ray, laboratory, and other procedures by injury type and time of day
11. Minutes per day each resource unit (defibrillator, registered nurse, cast room, cubicle, observation bed, M.D., and so forth) in ER is in use
12. Cost, charges, and income per visit
13. Patient characteristics: age, sex, race, health insurance coverage, private physician, residence, occupation, education.

Most of these measures of hospital and ambulance utilization are descriptive rather than evaluative and do not allow qualitative judgments beyond interfacility comparisons as to waiting time, costs, and other items and comparisons between the project area and other regions on gross

Interaction sequence between resources and need

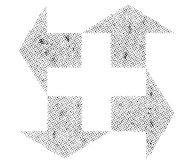


utilization parameters. Additional evaluative criteria are necessary to make such comparisons.

Evaluative Criteria for Utilization

A physician-registered nurse team can make several clinical judgments from the survey data mentioned previously (ambulance trip data, ER medical records, dispatch records, death certificates) that allow, through record linkage, a clear history of an EMS incident from occurrence through detection and ambulance use to hospital treatment and death or recovery. From these judgments, the following percentages can be computed.

1. Runs with inappropriate first aid procedures performed
2. Runs with appropriate first aid procedures not performed
3. Runs when first aid procedures required by the patient's clinical condition necessitated greater training than that of the ambulance crew
4. Deaths at the scene, deaths en route, and deaths after hospital arrival attributable to first aid procedures withheld or delay in reaching hospital
5. Patients receiving ambulance service who needed it for clinical reasons



6. Hospital's ER patients clinically needing ambulance service who actually received it.

Criterion 3 would produce vital information on the disparity between actual and needed training of the ambulance crew—information more appropriate than the present largely undocumented and expensive assumption that all ambulance personnel should receive the highest possible training. Data on criteria 1–3 might be displayed as in format 6.

Criteria 5 (ambulance sensitivity index) and criteria 6 (ambulance specificity index) depend on abstracted data from the ER records and the clinical interpretation of it. In format 7, data from the city of Chicago for June 3–9, 1969, are used as an example.

Ideally, both indices ought to closely approach 100 percent and if they do not, the availability of ambulances, the decision-making processes (whether to dispatch an ambulance in response to a request) of the ambulance dispatch system, and the public visibility of the ambulance call procedures ought to be examined. Criterion 6 should also be applied to calls for ambulance assistance whether or not the person subsequently entered the EMS system alive. Since criterion 6 is, of course, a measure of unmet ambulance need, false-negative calls (appropriate patient calls for an ambulance that incorrectly did not receive service) should be followed up in detail.

Similar evaluation criteria may be developed for utilization of hospital ERs from abstracting

Format 6. Comparison of actual and needed training of ambulance crews, in number of runs

Actual training level	Patient's condition required training to level of—			
	Red Cross Standard	Red Cross Advanced	Medical emergency training	Beyond medical emergency training
Red Cross Standard	a	b	c	d
Red Cross Advanced	e	f	g	h
MET	i	j	k	l
Beyond MET	m	n	o	p

NOTE: A satisfactory level of training would be a+f+k+p÷all runs=100 percent. The degree o undertraining may be measured as b+c+d+g+h+l÷all runs=? percent, and the degree o overtraining as e+i+j+m+n+o÷all runs=? percent.

Format 7. Comparison of clinically determined need for, and actual receipt of, ambulance service by a hospital's emergency room patients

Received ambulance service	Clinically determined need for ambulance service		
	Yes	No	Total
Yes	A= 345	B= 63	408
No	C=1,491	D= 943	2,434
Total	1,836	1,006	2,842

NOTE: Ambulance sensitivity index is A÷A+B or 84 percent. Ambulance specificity index is A÷A+C or 19 percent.

records, interviews with patients, autopsy reports, death certificates, and the resulting clinical judgments. These criteria include:

7. Proportion of ER patients treated at hospitals with EMS resources greater than those required by the clinical condition

8. Proportion of ER patients treated at hospitals with EMS resources less than those required by the clinical condition.

Both these criteria require a categorization of each hospital's EMS resources and of the resources necessitated by the patient's clinical state. The data should be displayed in two major formats. First, in format 8 aggregate data for the entire project area are displayed.

(which hospitals the ambulances take which patients to) or patient flow patterns (which hospitals the patients seek out for care) or the geographic location of EMS facilities relative to patient need.

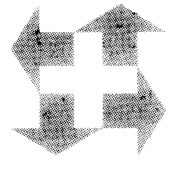
Thus, alternative change strategies to be based on data would include compelling or encouraging ambulances to take patients only to designated receiving hospitals, attempts at public education of potential patients as to where they should go, or categorization of hospital ER facilities. As a basis for determining the appropriate strategy, these data can also be reported from geographic subareas and from individual hospitals by using format 9. The additional category of "ER not

Format 8. Comparison of actual use and clinical need for emergency medical services of hospitals, by emergency room (ER) category

ER category used	Number of patients by ER clinically needed category		
	Comprehensive	Major	Basic
Comprehensive	a	b	c
Major	d	e	f
Basic	g	h	i

NOTE: Adequate response is a+e+i÷all cases=100 percent. Over-response is b+c+f÷all cases=? percent. Under-response is d+g+h÷all cases=? percent.

These data on ER use ought to be analyzed separately for ambulance and nonambulance cases, since needed manipulative strategies differ in terms of whether the over- or under-response of the system is attributable to (and therefore changeable by) ambulance dispatch patterns



needed" in format 9 is crucial in analyzing system over-response to the vast majority of ER visits, which are for primary walk-in care. It is the basis for these two important criteria.

9. Proportion of visits (by hospital, demographic, and geographic groupings) that did not require the resources of a hospital ER

10. Proportion of non-necessary ER visits that required only resources of an outpatient department clinic, 24-hour hospital "convenience" clinic, private physician's office, nonhospital public health facility (well-baby clinic, neighborhood health center) or no health resources at all.

With data for criterion 10, the availability of

alternate ambulatory care resources and the potential demand for an ER substitute should be examined for each subarea of the region characterized by high utilization of the ER for primary care (format 10). From this compilation, determinations may be made as to whether alternate

Format 9. Comparison of actual use and clinical need for emergency medical services of hospitals, by emergency room (ER) category, in percent of ER visits

ER category used	Clinically needed visits			ER not needed	Total
	Comprehensive	Major	Basic		
Comprehensive:					
Hospital 1.....					100
Hospital 2.....					100
Major:					
Hospital 3.....					100
Hospital 4.....					100
Basic:					
Hospital 5.....					100
Hospital 6.....					100
Subarea:					
City.....					100
Inner city.....					100
Suburbs.....					100
Total.....					

Format 10. Potential demand for alternative ambulatory care resources among inappropriate users of emergency room (ER), in number of visits per year

Alternate resource	Potential visits from present ER use	Is alternate resource available?	How many additional visits can alternate resource handle?
Private physicians.....			
Well-baby clinics.....			
Hospital outpatient department.....			
24-hour hospital convenience clinic.....			
Neighborhood health center.....			

facilities exist and, if not, the potential demand for them, as well as determinations as to appropriate strategies to encourage their use. It is clear that these determinations require not only data on available resources and the clinical care needed, but also data from interviews of patients on their attitudes, perceptions, and behavior toward the ER and toward alternate points for health services delivery. The final criterion for utilization evaluation follows.

11. Percent of ER visits in each diagnostic category with appropriate treatment (over-treatment vs. under-treatment).

This criterion will be more detailed than normal medical audit or peer review in the hospital ER (format 11).

Outcome Measures

Ironically, the most important aspect of emergency medical services—outcome of the patient's condition—has been studied least. Research and

Format 11. Appropriateness of medical care

Phase	Procedure—			
	Given and indicated	Not given but indicated	Given but not indicated	Indicated, beyond hospital's ER resources
Diagnosis:				
Laboratory.....				
X-ray.....				
Physical examination.....				
Consultation (service).....				
Treatment:				
Disposition:				

evaluation has overwhelmingly concentrated on measures of resources and patient needs (input) and utilization (throughput) to judge the need for EMS activities and their subsequent effect. Typically evaluation is built around such statements as "the project trained X ambulance attendants," "installed X radio links between hospitals and ambulances," "reduced ambulance trip time by 2 percent," or "rerouted most trauma cases from category 3 to category 1 hospital ERs." Outcome measures are ignored as is the need to quantify the independent effect of separate EMS activities such as training, communications, central dispatch, and categorization. The nearest approach to EMS outcome measures currently are mainly clinical impressions from autopsy and other records that a given number of deaths were "salvageable"—with no detailed or realistic specification as to the conditions (availability of resources and utilization) that would have averted the deaths.

There are several difficulties in developing outcomes measures. First, what measures are appropriate for conditions in which death is not a likely outcome? Second, since outcome is a function of resources, clinical condition, and utilization, which criteria will measure the separate effect on outcome of different levels of resources and their use independently from the effect of the patient's clinical condition?

Ironically, there is little in the research literature to disprove the possible notion that the emergency system is dealing with a finite set of patients who are going to die or survive solely as a function of their condition and that the only effect of EMS expenditures is in influencing when and where death takes place. Indeed, a reasonable interpretation of the scattered available data is that the independent effect of communication activities is to reduce the patient's delay in reaching the hospital and to increase deaths after arrival by decreasing deaths at the scene or en route. (The same number of deaths occur and at the same intervals after onset, but a greater number of this finite set of deaths takes place in the hospital than previously).

Similarly, a reasonable interpretation of the scattered data on the independent effect of ambulance crew training is that training increases the delay in the patient's reaching the hospital, whether or not his condition requires treatment at the site such as splinting or stabilization, and increases "deaths on arrival" at the hospital by reducing deaths after arrival at the hospital. The same number of deaths occur, but more of them take place at the scene or en route to the hospital.

The third difficulty in devising EMS outcome measures is that aggregate death rates (even age-, sex-, and diagnostic-specific) are notoriously insensitive to EMS intervention and too gross an indicator to measure change. Death rates for stroke, myocardial infarction, drowning, drug overdose, and homicide, for example, do not distinguish between localities generally regarded as having excellent EMS and those with poor services. Thus death rates are a poor evaluation measure of EMS, either because they are insensitive to change or because EMS has little effect on them.

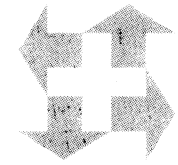
The final difficulty is that since an outcome for one subsystem of EMS is an input for another system, it is conceptually problematic as to whether there is one set of outcomes for the entire system or a sequential set of input-process-output-input from a series of subsystems—from detection to dispatch to ambulance to hospital ER to hospital critical or intensive care unit.

Despite this dilemma, outcome measures must be developed if only to invite criticism and improvement. The following measures are suggested.

OUTCOME MEASURES

1. Percent of patients who survive
2. Disability days per patient, defined as days from onset of precipitating condition to complete resumption of patient's normal role and comprising (*a*) days confined to bed, (*b*) days confined to home although not to bed, and (*c*) days patient could not fully engage in normal activities because of clinical condition
3. Percent of cases in which patients are residually impaired in activities of daily living
4. Age- and sex-specific death rates from EMS-related causes of death
5. Percent of EMS-related deaths of persons entering system before death
6. Percent of patients satisfied with EMS
7. Patient score on the Cornell Medical Index (symptom score) 6 months and 12 months after EMS incident
8. Percent of cases in which patient died at scene on arrival of ambulance, at scene after arrival of ambulance, en route to hospital, and after hospital arrival
9. Mean number of minutes from onset to death.

If these outcome measures are to be used to judge the effect of the emergency system from the effect of the clinical condition and to quantify independently the outcome effect of separate elements of the EMS system, they must be standardized for clinical condition and presented as in format 12.



To secure valid measures, a sufficiently large series for each clinical condition and each EMS element will be necessary so that the effect of clinical severity can be factored out and, by partial regression equations, the independent effect of each EMS element on outcome may be evaluated. For example, what is the outcome of hospital X on cardiovascular arrests when clinical severity, patient characteristics, and ambulance treatment are controlled, or what is the outcome effect of ambulance Y on myocardial infarctions when patient characteristics, clinical severity, and receiving hospital are controlled?

Ongoing Program Evaluation

The first part of these guidelines described research techniques for baseline evaluation of EMS before and as a basis for intervention; this final section deals with techniques for the ongoing evaluation of the effects of intervention. Intervention activities typically include some or all of the following features: training of ambulance attendants, installation of radio links between ambulances and receiving hospitals, the introduction of a central dispatch system, the upgrading of ambulance and hospital resources, categorization strategies to reroute certain patients, public information campaigns to persuade walk-in patients to go to a different hospital emergency room or not to go to a hospital emergency room.

Format 12. Effect of emergency medical services elements on outcome, by measures of clinical condition

Outcome measure	Hospital element				Ambulance element			
	1	2	3	4	1	2	3	4
Myocardial infarction:								
Percent survival								
Disability days per patient								
Percent residual impairment								
Compound fracture, femur:								
Disability days								
Percent patients satisfied								
Cardiovascular arrest:								
Percent survival								
Minutes to death								
Pelvic inflammatory disease: Percent asymptomatic after 6 months								

Format 13. Resources, utilization, and outcome measurse before and after intervention in project and control areas

Measures of—[1]	Project area		Control area	
	Pre-intervention **a**	Post-intervention **b**	Pre-intervention **c**	Post-intervention **d**
Hospital resources (items 1–5)				
Ambulance resources (items 1–4)				
Resources to population ratios (items 1–10 in format 3)				
Ambulance utilization (items 1–10)				
Hospital utilization (items 1–13)				
Utilization evaluation (items 1–11)				
Outcome (items 1–9)				

[1] See text and format 3 for items.

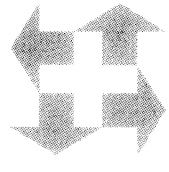
NOTE: For each measure, the effect of intervention may be defined as (column **b**−column **a**) −(column **d**−column **c**).

Format 14. Effect of training ambulance crews and setting up ambulance-hospital radio links on mortality

Item	Ambulance t+ r+ **a**	Ambulance t+ r− **b**	Ambulance t− r+ **c**	Ambulance t− r− **d**
Mean time:				
Dispatch				
Scene arrival				
At scene				
Scene to hospital				
Mortality:				
Percent dead at scene				
Percent dead on arrival				
Percent dead after arrival				

NOTE: t+ =received training, t− =no training, r+ =radio link to hospital, t− =no radio link to hospital.

The assumptions of intervention to be tested are that the activities just mentioned improve resources, which improves utilization, which improves outcomes. Since this assumption involves the same model as that for baseline evaluation, most of the resource, utilization, and outcome measures previously mentioned may be used for ongoing evaluation. The ongoing evaluation involves two sets of comparisons: first—before, during, and after intervention and second—between changes in the project area and changes in a comparable control area. Format 13 is suggested for charting these comparisons.



It is clear, however, that format 13 only allows the effect of intervention to be measured at a gross level and only for the entire project area. It is also necessary to evaluate the effects of particular interventions within the area. Since treatment or change cannot immediately be applied to all EMS elements in the area simultaneously, more detailed research designs are possible during the duration of the project. Thus, certain ambulance companies will receive training and others will not. These circumstances allow for the cross-sectional research design shown in format 14.

Thus, there are two independent estimates of the effect of training: column **a** in format 14 minus column **c** and column **b** minus column **d.** The two estimates of the effect of radio links with hospitals are column **c** minus column **b** and column **a** minus column **d.** Similar research designs may be generated to estimate the effect of other

intervention activities on other elements of EMS.

The final set of evaluative criteria has to do with the increasingly important task of measuring the extent to which an EMS project has achieved certain exogenous goals set by the funding agency. It is apparent that several agencies at the Federal level, including the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA), Comprehensive Health Planning Service (CHPS), Regional Medical Programs Service (RMPS), Health Services Administration (HSA), and Health Resources Administration (HRA), as well as the Departments of Transportation and Defense, are funding EMS projects, in part to achieve general mission goals of these agencies. Thus, while some agencies have earmarked funds for EMS, others make EMS grants out of a general budget allocation. Clearly, the agencies at the Washington, regional, and local levels must concern themselves, in making the initial funding and subsequent refunding decisions, with the question not so much of whether a given application is a "good" EMS project or not, but rather with whether a particular project is the best means of achieving the overall mission of the agency. Since EMS projects are, in this setting, competing with non-EMS projects, evaluation must be concerned at the proposal, refunding, and project conclusion stages with the following questions.

1. Does the EMS project have a regionalizing effect on health services? (RMPS)
2. Is it maximizing the influence of consumers over providers? (CHPS)
3. Does it deal with psychiatric emergencies, drug overdoses, crisis intervention, and so forth? (ADAMHA)
4. Will the EMS project be taken over financially and administratively by a community-wide health agency at the conclusion of the project period? (HSA)
5. Does it lead to innovative manpower use of the physician substitute? (HRA)
6. Does it lead to better law enforcement and public protection? (Law Enforcement Assistance Agency)
7. Will it result in secondary prevention of disability? (Social and Rehabilitation Service, Social Security Administration)

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The Emergency Medical Services Systems Act of 1973, in making available $185 million for the development or expansion of emergency medical services, places great emphasis on research and evaluation. The act requires, and recent improvements in research technique make it possible, that funding applications justify the need for funds and evaluate the impact of funded activities in process and outcome evaluation terms much more sophisticated than the traditional "ambulance counting."

This paper outlines several methodologies and formats for securing and presenting (*a*) baseline evaluation data on the pre-intervention state of emergency medical services in a service area and (*b*) impact evaluation data to measure the nature of change brought about by intervention. Methodologies and data formats are presented to analyze resources, patient needs, utilization, and outcomes of emergency medical services.