CHAPTER 3: PLANNING AND EVALUATING EHC

EMS PROGRAM ASSESSMENT BY EPIDEMIOLOGIC METHODS

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Emergency medical services (EMS) programs must be designed to meet the needs of their service area and continually evaluated to ensure effectiveness. The need for EMS, the effects of EMS programs, and the worth of new EMS techniques are generally evaluated by epidemiologic studies. EMS managers should thus be familiar with basic epidemiologic methods.

This paper presents an overview of sources of epidemiologic data and of measurement of health and disease in populations. It surveys epidemiologic study design and comments on statistical methods. Finally, it describes the interpretation of the results of epidemiologic studies. Later papers give specific examples of the application of these methods in management of emergency medical services.

Epidemiology is not a black art reserved to an elite priesthood. Any one of us practicing at an inner-city hospital, for example, could observe that on Friday nights we admit a lot of 20 year old males who were injured in tavern fights. That would represent an epidemiologic observation. Some of us of broader experience and perspective might go a bit further and advise our younger colleagues to stay out of the Yellow Frog Bar on the corner. That represented an injury prevention campaign. Epidemiology is thus a means of identifying causes of disease or injury from observation of disease patterns; its chief use is to guide disease control measures.

The epidemiologic method goes back to prehistoric times. The earliest written descriptions that come readily to mind are the writings of Hippocrates in the 4th-5th century BC Hebrew, Sanskrit, and Chinese writings of equally ancient provenance also discuss disease dynamics in populations and the influence of environment on disease.

Epidemiology is formally defined as the study of the distribution and dynamics of disease By the distribution of a disease we mean the personal characteristics of its victims, ie. the part of the population that it affects. By dynamics we mean the time course of its occurrence, and the way that its occurrence is influenced by the environment in which it occurs.

Epidemiology is useful to health care planners and managers. For us, its main uses are to ascertain the causes of disease; to measure the nature and the magnitude of health care problems; and to evaluate the success of health care programs.

DISEASE CAUSATION

Let me first touch on the semantics of disease causation. A few diseases, mostly infectious or toxic diseases, are brought about by a particular single cause or agent. For these diseases a single exposure to an adequate dose of agent is both necessary and sufficient to cause the disease. However, most disease entities are multifactorial in origin. No single agent is sufficient of itself, and there may even be no single necessary agent.

The multiple factors responsible for the occurrence of disease can be looked upon as host factors that increase the susceptibility of the host, agent factors that increase the virulence or the strength of the agent or agents, and environmental factors that increase the exposure of the host to the agent.

Let's examine a hypothetical Friday night stabbing. We might identify a knife as the principal agent of injury. However, simple exposure to a knife isn't enough; each one of us is exposed to knives every time we visit our kitchen. Host factors present in the temperament of young men put knives in their pockets, induce them to display their prowess, and increase their susceptibility to conflict. A rowdy tavern on Friday night may contain several environmental factors, perhaps including women and strong drink, that further increase risk of conflict between young men. Finally, no single factor is even necessary, not even a knife; a motivated assailant can do similar damage with a broken bottle, an ice pick, or a broken pool cue.

"Factors" may have positive or negative influence over the development of disease, that is, they may be associated with in creased or with decreased risk. Exposure to biologic agents or toxins usually increases the risk of disease. Conversely, in at least some happy circumstances, exposure to medical care may decrease the risk of disease.

Virtually all diseases and injuries requiring emergency health care originate from multiple causes acting in synergy. Their epidemiology can thus be quite complex.

SOURCES OF EPIDEMIOLOGIC DATA

There are many sources of epidemiologic data. Reports of notifiable diseases are usually irrelevant to emergency health care. Birth registrations are of minor utility to emergency health care planners. Death registrations contain considerable information relevant to emergency health care. So do data from medical care providers and institutions. Included in this group are hospital and clinic admissions, clinical records, health insurance enrollments, and health care reimbursement records. In American and European environments with complex medical record systems, these sources are the ones most frequently used for emergency health care research. Disease registries are sometimes useful for uncommon diseases. Industrial accident reports (such as

OSHA and NTSB reports) are a sort of registry, and they often contain plentiful data relevant to injury causation and to medical care needs. EMS investigators often use non-medical data sources such as ambulance run reports, school and industrial absenteeism, prescription drug sales, and the like to glean useful information on illness, injury, and health care needs. Data from routine health surveys - the US National Health Interview Survey, for example - may contain information relevant to emergency care needs. When no existing source of data is suitable, it is sometimes practical to obtain the requisite data from specially designed community surveys or other special studies.

Information about the populations at risk is just as important as information about disease occurrence. A recent, detailed, and reliable census of the population is therefore a vital part of the epidemiologic armamentarium.

MEASUREMENT OF DISEASE

The simplest epidemiologic statistic simply counts the number of cases or conditions. This is adequate if the population at risk doesn't vary.

The first and most important step is to remove the effect of differing population bases by converting our statistics from numbers to rates. We do this by dividing through by the population at risk. Since we then have a small decimal fraction, we increase it to a suitable size by multiplying by a scale factor (100, 1000, 1,000,000, etc.).

The general form of an epidemiologic rate is therefore:

$$\frac{\text{cases}}{\text{population at risk}} * \text{scale factor}$$

Frequently used examples are birth rates, death rates, infant mortality rates, and morbidity rates.

Such rates can apply to the whole population. In that case they are called crude rates. Risk of disease varies by age and sex, however, so we often use age- and sex-specific rates for each significant age and sex group. When this is unwieldy, we can use an adjusted rate which is adjusted to represent a standardized population.

Overall mortality rates are useful only for the roughest comparisons of health conditions. Most of the rates used in epidemiologic studies or health services research are cause-specific rates.

Rates can measure incidence or prevalence. Incidence, as it sounds, measures the proportion of new incidents among the study population during a period of time. Prevalence, in contrast, measures the proportion of the population that has the condition at a point in time. Incidence and prevalence are related, prevalence is approximately equal to incidence times average duration. Chronic conditions of long duration accumulate in the population, so that point prevalence far exceeds incidence. Conversely, single-point occurrences (like accidents) have only an incidence rate; a prevalence rate is impossible since the occurrence happens only at a single instant.

EPIDEMIOLOGIC STUDY DESIGN

Virtually all epidemiologic studies fall into two classes: "descriptive" studies and "analytic" studies. These two basic kinds of epidemiologic study call for different methodologies and of course different study designs.

Descriptive studies simply describe the occurrence of disease in terms of the environment in which it occurs and the characteristics of disease victims. The classical descriptive factors are time, place, and person. Most studies designed to measure health care needs fall into this class. They are designed to measure the number of cases of a condition, or to describe the characteristics of cases. Most health care needs assessments fit this model. An example in EMS would be the typical ambulance needs survey.

Analytic studies test hypotheses about the association of diseases or conditions with risk factors. Analytic studies contrast two or more groups and attempt to determine whether there is a statistical association between the study condition and the suspect factor Most studies of health care effectiveness fall into this class. They are designed to determine whether the health program or treatment is associated with improved outcome. Excellent examples in the EMS field are Dr. Eisenberg's studies on the effect of advanced cardiac life support on cardiac mortality in Seattle. Analytic studies may take one of three major forms: the cross-sectional study, the retrospective study, or the prospective study

The cross-sectional study is founded on a single selected sample of a population, or of cases of illness. Each member is observed and his status with respect to disease and suspected risk factors is recorded. A purely statistical analysis is carried out, and any statistical associations between disease and suspect factors is noted. A typical observation might be that a large fraction of hip fracture admissions are elderly women.

The retrospective study is founded on two related samples, one made up of proven cases and one made up of controls who are free of the disease or condition under study. All individuals are observed or tested for suspect risk factors. The two groups are then compared statistically. A higher prevalence of a suspect risk factor in the case group, if statistically significant, may indicate a possible causal relationship between the factor and the disease. A typical observation might be that there are more smokers among lung cancer cases than among controls.

The prospective study is founded on two related samples, in this case representing persons proven exposed to the suspect factor, and the other proven not exposed. Alternatively, several test groups may be differentiated by differing levels of exposure to the suspect factor. The groups are then observed for the subsequent development of disease. An increased incidence of disease in the exposed group, if statistically significant, may be evidence of a causal association. A typical study finding might be that people who use seat belts have lower mortality from auto accidents.

There are two other study types that fall generally under the rubric of prospective studies. One is the historical prospective study, in which historical data are used to identify panels of individuals who were exposed or not exposed to the suspect factor in the past. Their subsequent incidence of disease is compared in the same manner as the ordinary prospective study, and similar conclusions can be drawn. Another is the experiment, which is a prospective study in which the investigator controls each participant's exposure to the suspect factor.

Retrospective studies are widely used because they are quick and cheap. However, the study design is quite susceptible to bias. Prospective studies are usually expensive and time-consuming, but less susceptible to bias; their conclusions are therefore more reliable and highly valued.

TESTS OF STATISTICAL SIGNIFICANCE

No analytic study should be conducted without appropriate statistical tests of the significance of the results. Such studies are virtually always designed to test a null hypothesis, that is, that any observed difference is small enough to be attributable to chance. For simple studies using small study groups and raw numbers, simple chi-square tests are usually appropriate. For larger studies which compare incidence or prevalence rates, ordinary T-tests or Z-tests for difference of proportions are adequate. For more elaborate study designs involving simultaneous testing of several suspect factors, multivariate methods such as analysis of variance or multiple regression can be used.

INTERPRETING RESULTS

Just observing a statistically significant association between a suspect factor and a health condition does not necessarily mean that there is any causal relationship between the two. The association that is observed may be due to bias in the study design, or the two variables may instead be joint covariates of a third true cause. In order to attribute causal influence to any suspect factor, the association should be demonstrated repeatedly and strongly in different studies, or a causal relationship should be demonstrated by experiment. This is especially important with evaluation of programs commanding great community or professional interest, such as emergency medical services programs, which create incentives for observer and subject bias.

SUMMARY

This discussion has reviewed the fundamental concepts of epidemiologic and statistical analysis. It described sources of epidemiologic data. It described measurement of health and disease in populations, with particular attention to the use of incidence and prevalence measures. It reviewed epidemiologic study design, touching on both descriptive and analytic methods, and defining retrospective and prospective methods. Finally, it mentioned the need for tests of statistical significance, and concluded that epidemiologic studies should be interpreted conservatively, to ensure that statistical associations are valid indicators of causality, and not the accidental results of confounding factors.

DEVELOPING AN EMS INFORMATION BASE

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INTRODUCTION

The underlying assumption on which an EMS system is based is that the major focus is the patient. EMS planners/evaluators frequently lose sight of the patient because it is easier to collect data on equipment, training programs, number of classes, number of students, etc. My presentation today will describe the characteristics of an EMS information base and the methodology for linking statewide data bases.

An EMS information base must be patient based. That means it must include patient specific records.

An EMS information base must be designed using a systems approach. That means the information base must include for each patient multiple records each of which is collected at different phases of the emergency: at the scene, enroute, at the emergency department, at discharge, and during rehabilitation.

An EMS information base must be regional or statewide to permit population based analyses of cross site comparisons, particularly urban and rural.

An EMS information base is resource dependent. That means what you want may not be possible because of the lack of trained staff, appropriate equipment, or political obstacles blocking access to the data you need.

DATA SOURCES

The major sources of EMS data include the following:

Police crash report
Ambulance run report
Emergency department log and patient record
Hospital discharge diagnosis data and patient record
Trauma registries

Death certificates
Licensure training records

Only the ambulance run report data is usually controlled by EMS. The remaining data bases are collected by other agencies or facilities. EMS must negotiate to access the EMS related data not controlled by EMS.

I am not going to discuss in detail how to develop and implement an ambulance run report data system in your area except to say that the following steps are important:

1. You must determine a minimum data set.
2. You must consider format issues: size, shape, print styles, horizontal/vertical layout, check off/narrative, key punch/optical scan, etc., and you must develop a consensus process for deciding the final format of the form.
3. To ensure 100% compliance, you must have a mandate to collect the data.
4. You must develop a process for frequent feedback to the data providers.

INTEGRATED EMS INFORMATION SYSTEM AND DATA LINKAGE

An integrated EMS information system has the capability of tracing a patient from the scene to the hospital. This is accomplished through data linkage or what we referred to as coordinated record keeping in the late 70's. At that time, we linked records manually, a tedious, labor-intensive activity. Now we link records using the computer.

Linkage of statewide data bases has many advantages. It provides access to new data without additional data collection. We can link the run report to discharge data to obtain outcome data and to the police crash report to obtain data describing accident characteristics.

Linkage provides access to data generally inaccessible to EMS. For example, charge data recorded on the hospital discharge diagnosis abstract provides EMS and highway safety with access to financial information specifically related to motor vehicle injuries.

Linkage provides an opportunity for the various data staffs to work together and share information about how to make the linkage process more efficient. For example, space to record the license plate number of the ambulance vehicle was added to Maine's police crash report to facilitate linkage of the report with ambulance run reports.

Linkage identifies errors which otherwise would remain undetected. Thus the data becomes more accurate in addition to more useful.

Computerized linkage produces a permanent link. Sometimes the link is a unique identification number assigned to the matched records at the time of linkage. The records remain separate until linked via the number. Another form of linkage produces a merged record. Use of either method makes it unnecessary to relink the records when linked data is needed.

Use of statewide data eliminates most of the problems related to ensuring a representative sample while at the same time providing access to data which would be too expensive and time consuming to collect for a single research project. Although missing data must be considered, a rate as high as 30% still generates sufficient records for small area analysis. In addition, records with missing data can be reviewed to identify where skewing might occur.

DATA LINKAGE METHODOLOGY

The rest of my presentation will focus on the methodology for data linkage.

Linkage Variables

There are two types of linkage variables: direct and indirect. A direct linkage variable is used as a single variable to identify a specific person.

The following list includes examples of direct linkage variables:

Name (may have to be combined with other variables such as date of birth, residence code, etc. if the data base is large enough to include a large number of duplicate names.)
License number
Inpatient record number
Social security number

Indirect linkage variables describe personal characteristics. An indirect variable must be combined with other indirect variables to describe a specific person. The most common group of indirect variables used for EMS linkage is listed below:

Age/birthdate
Sex
Date
Pick up location (town, county)
Name (identification code) of hospital where treated

Matching Concepts

Presence of a direct variable simplifies the matching process by greatly reducing the time needed to verify matches. Problems are usually limited to mistakes recording the direct variable, ie. misspelling the name, entering a number with reversed digits, etc.

Indirect variables complicate the matching process. Data linkage enables a patient to be traced from the scene to final disposition. Because patients range in severity from minor to life threatening, the number of patients identified at the scene is greater than the number transported, treated in the ED, or admitted as inpatients. Thus, the first matching concept to consider for EMS matching is that records in data base A are not expected to match all the records in data base B and vice versa. This concept applies whether you trace the patient from the scene to the hospital or from the hospital to the scene. Matches may occur as one to one, many to one, or one to many. The matching process must be both restrictive to minimize duplicate matches and flexible to generate a high match rate.

The second concept to consider for EMS indirect matching is that files should be reduced for more efficient matching. The construction of sub-files makes it possible to exclude records which are ineligible for matching; for example, excluding all non-trauma cases from the run report file before you link the crash reports with the run reports.

The third concept to consider is that sub-files matched in the order of the probability for a match are more likely to produce the most valid matches. Thus the more serious (fatal, incapacitating) injuries, which are known to have a higher transport rate, are matched first and the less serious last.

The sequence of matching can be from the scene to the hospital or vice versa. The latter is facilitated if an E code is implemented to identify all the motor vehicle discharges. Matching from the hospital to the scene involves fewer records but usually generates insufficient records for most population based analyses and excludes extremes (died at scene, minor injury).

Not all duplicates can be avoided. Thus a verification process using both computer and manual review of the duplicate records is necessary to choose the correct match. A printout listing similar information from the record to be matched and all the records it matches provides an efficient method for manually choosing the correct match. Typical information recorded on the printout include hospital diagnosis codes to compare with the area of injury on the crash report, time of report to the police to compare with time of EMS call, position of the patient in the vehicle (driver/passenger front seat/back seat) to compare with narrative description on run report, destination time on run report to compare with admit hour on hospital record, etc. Although duplicate matches can be validated using the printout, frequently the run report is pulled to obtain more information from the narrative.

Linkage Problems

The most common linkage problem involves missing or inaccurate data. Age or times may be recorded incorrectly or not at all. Missing or inaccurate data on a record in one file may preclude the possibility of matching it in another file.

Another common problem is caused by multiple records. The EMS data base has the potential of including multiple records for the same patient: rescue, basic life support, advanced life support, transfer to an airport, air ambulance, transfer from a second airport, transfer after admission just to name a few. In this instance a match to multiple records for the same patient may be correct. Multiple matches also occur where multiple patients have the same age and sex, for example, the 19 year old male. It may be impossible to determine who was the driver or a passenger without referring to the narrative section of the run report.

Inconsistent data causes problems. When different people record times, the times will vary. In some instances this means that the time of the accident will be recorded at a time later than the time of the EMS call. A verification process is necessary to determine correct matches.

Matching Algorithm

A matching algorithm consists of a sequence of steps which when followed increases the probability of a match. The sequence is designed to compensate for missing, inaccurate, and/or inconsistent data to improve the match rate. For example, most EMS algorithms usually adjust age and date because patients forget their age at the scene and late night transports usually are admitted the next day. Times are difficult to use for matching because of the probability for variation. But they are useful during the verification process and are best used as ranges such as plus or minus thirty minutes

USEFULNESS OF LINKED DATA

In Maine, we have linked 1) crash reports for the first six months of 1986 and all of 1987; and 2) all pediatric emergencies for 1987. We also expect to link serious motor vehicle injuries for 1988 and to use the linked data bases as the beginning of an injury surveillance system for Maine.

During 1986 (6 months) and 1987, 60% of the fatal injuries, 70-80% of the incapacitating injuries, and 30-40% of the non-incapacitating injuries were transported by ambulance. These percentages represent 55% of the "serious injuries."

We used the linked data bases to evaluate the impact of pediatric emergency training on pediatric transports. By the first quarter in 1989, 21% of the pediatric transports were treated by at least one crew member trained by the pediatric emergency project.

We wanted to see if pediatric emergency training improved pediatric assessment skills. All trainees were retaught how to take vital signs for pediatric patients. Run reports for pediatric transports were reviewed quarterly to compare vital sign completion rates between trained and untrained personnel. Compliance was found to be higher for trained compared to non-trained crew members and rates were consistently lower for the youngest pediatric transports regardless of training.

We traced pediatric serious MVA injuries (defined by the police at the scene as fatal, incapacitating, and non-incapacitating) and compared access, response, and destination times for different geographical locations. The "golden hour" standard for arrival in the operating room is difficult if not impossible to meet in rural areas, questionable for suburban areas, and almost always possible for urban and metro areas in Maine.

Our data shows that access time, or the time between when an accident occurs and when EMS is called, is long enough to negate the benefit of EMS in some areas. We expect the linked data base to provide us with the documentation necessary to target highway safety and EMS programs to those areas where the public has the most problem accessing EMS.

SUMMARY

To summarize, patient based planning for an emergency medical services system depends on linked patient records to determine what makes a difference to outcome at the scene, enroute, and at the hospital. Linkage of statewide data bases facilitates small area analyses of unmet need while at the same time expanding available data without additional data collection. Thus highway safety and EMS planners will be able to efficiently target interventions where their impact will be the most effective.

ADVANCED LIFE SUPPORT MEDICAL CASE DISTRIBUTION IN A RURAL/URBAN POPULATION

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INTRODUCTION

In the preface to the American College of Emergency Physicians' text Principles of EMS Systems, Ronald Crowell poses four questions confronting emergency medical services:

1. What prehospital interventions are efficacious in reducing morbidity and mortality, and are the benefits of intervention worth the risks?
2. Can we justify long field times in short transport time situations?
3. What is the cost-benefit ratio of the ever-enlarging scope of prehospital practice?
4. Can medical science help us determine how an ideal paramedic would be configured in both long and short transport times systems? [1]

Critical to answering these questions is the definition of the practice of prehospital emergency medical care. Despite the rapid development of emergency medical systems throughout the United States, little has been done to define the scope of services rendered. Advanced life support services developed from the concept of administering early cardiac care to patients prior to arrival at the hospital [2]. These services have expanded to treat a variety of patient problems, but their results are seldom formally examined. A standard patient classification system has not been established for prehospital ALS. In this study the International Classification of Diseases, 9th revision, with clinical modification was applied to non-traumatic ALS cases so as to define the clinical scope of practice and the system mortality. These characteristics must be defined if the value of ALS care is to be determined.

METHODS

The study utilized a service area of 460 square miles and a population base of 143,549. By 1980 census definition, the area was 10% urbanized, and the population was 48% urban. This area had primary response coverage by 3 ALS services who were dual-dispatched with 12 basic life support (BLS) services All ALS calls from this service area from January 1 to December 31, 1987 were reviewed regardless of hospital destination. Excluded from analysis were cancelled calls, calls in which patients were released to BLS providers, and interhospital transport calls. Admitting and final diagnoses were sought for every patient not excluded. For those patients in whom a final diagnosis was obtained, a call etiology was assigned using the International Classification of Diseases, 9th revision, with clinical modification (ICD-9-CM). Trauma patients, including burns and drownings, were excluded. Because of their multiple injuries, these patients were judged to be more appropriately classified using a different system. All other patients were included in the study. Two of the authors (SAM and GLL) classified each patient according to admitting and final diagnosis. The chief complaint provided by the prehospital providers was used to select the most appropriate diagnosis when multiple or contradictory diagnoses were provided. Data was analyzed by specific disease entity and also by ICD-9 class (Exhibit 1). Specific diseases were grouped together to aid in data analysis (Exhibit 2) This included the groups "cardiac ischemia without myocardial infarction," "cerebrovascular disease", and "poison/toxins." Data was analyzed for occurrences, age distribution and mortality.

RESULTS

In 1987 there were 4,072 calls in the study service area. Of these calls there were 1,322 cancellations, 164 releases to BLS, 28 interhospital transfers, 418 trauma patients, and 2,140 transports. Out of the 2,140 medical transports, a final diagnosis could not be obtained on 29 patients or 1.4%. Eighty percent of patients could be classified into 21 treatment groups (Table 1). This classification includes a category of "rule out MI", which included all patients in whom myocardial infarction (MI) was considered but who did not have a final diagnosis of myocardial infarction. Reclassification of all patients by final diagnosis gives the distribution seen in Table 2. Analysis of patients by ICD-9 class revealed the highest percentage of patients to have etiologies attributable to the circulatory system. Tabulating the ICD-9 classes by patient age demonstrated changes in disease frequency with age. Cardiovascular disease is predominant over age 45, whereas symptoms and signs of undetermined etiology are predominant under age 35 (Table 3). Out of the 2,140 non-traumatic cases, final outcome could be obtained for 2,078. Of these, there were 264 deaths, giving a mortality of 12.7%. These deaths gave an incidence of 1.8 deaths per 1,000 population in the ALS service area. Vital statistics from the State of Pennsylvania indicate a death rate in the two counties of the service area of 10.2 and 10.0 per 1,000 population.[3] Non-traumatic deaths of patients transported by ALS units thus represent approximately 18% of all deaths occurring in the service area. Cardiovascular disease produced 75% of all deaths in the study. Seven diseases, cardiac arrest, respiratory failure, neoplasm, myocardial infarction, gastrointestinal (GI) bleeding, cerebrovascular disease, and congestive heart failure, produced 83% of deaths in the study, while representing only 26% of all cases (Table 4)

DISCUSSION

There has been little research concerning the case distribution of ALS services. Data is only available for the incidence of cardiac arrest. Braun et al [4], in reviewing multiple studies of cardiac arrest, reported a range of incidence of cardiac arrest at 75-103 per 1,000 population. The incidence in the current study of 83 per 1,000 population is comfortably within this range, indicating a comparable capture rate. There are no studies, however, with which to compare the incidence of other disease entities described. Since ALS care was initially designed to care for cardiac emergencies, it is not surprising that diseases of the circulatory system make up the largest percentage of patients transported. Given that cardiovascular disease is the leading cause of death in the United States, it is also not surprising that circulatory system disease produces the majority of ALS mortality. The incidence of many diseases transported by ALS services is known to vary with age. It should be expected that the incidence of ALS service transports varies with age. This relationship is important in comparing disease incidence in different systems, as differences in age distribution will lead to differences in disease distribution between two systems. In our system, excluding trauma, 18% of all persons dying received prehospital ALS care during the course of their final illness. Although this is a minority of all deaths, it represents a significant number. As many of the patients transported had preexisting terminal illness, it is apparent that EMS systems need specific policies for dealing with terminally ill patients.

CONCLUSION

The international classification of diseases, although not designed for application to prehospital care, is a useful system for the classification of non-traumatic prehospital cases. By using this system, we were able to demonstrate that circulatory disease produces the largest number of ALS patients and the majority of deaths. Case distribution is age-dependent, and therefore the frequency of disease entities is dependent on the age distribution of the population. In the system under study, the majority of deaths were produced by a limited minority of diseases: cardiac arrest, respiratory failure, neoplasm, myocardial infarction, gastrointestinal bleeding, cerebrovascular disease, and congestive heart failure.

References

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EXHIBIT 1

ICD-9 System Classes

Classes	ICD-9-CM
Infectious Diseases	001-139
Neoplasms	140-239
Endocrine/Metabolic Diseases	240-279
Diseases of Blood	280-289
Mental Disorders	290-319
Nervous System	320-389
Circulatory System	390-459
Respiratory System	460-519
Digestive System	520-579
Genitourinary System	580-629
Pregnancy, Childbirth & Puerperium	630-676
Diseases of Skin	680-709
Musculoskeletal	710-739
Congenital Abnormalities	740-759
Perinatal Conditions	760-779
Symptoms/Signs	780-799
Injury and Poisoning	800-899

EXHIBIT 2

Disease Groups

CARDIAC ISCHEMIA
WITHOUT MYOCARDIAL INFARCTION
(ICD9-CM 410-414)
Acute Coronary Insufficiency
Stable Angina
Unstable Angina

CEREBROVASCULAR DISEASE
(ICD9-CM 430-438)
Brain Infarct
Cerebral Artery Occulsion
Cerebral Hypertensive Crisis
Intracerebral Hemmorhage
Subarachnoid Hemmorhage
Transient Ischemic Attack

POISON/TOXIN
(ICD9-CM 960-989)
Ingested Poisons
Toxic Exposures
Smoke Inhalation
Carbon Monoxide Poisoning

TABLE 1
Non-traumatic Case Distribution with "Rule Out Myocardial Infarction" Included

Text	Number of Occurrences	Percent
R/O MI	210	9.8
MI	152	7.1
CHF	133	6.2
Seizure Disorder	129	6.0
Cardiac Arrest	120	5.6
Syncope	117	5.5
Cerebrovascular Disease	101	4.7
COPD	96	4.5
Hypoglycemia	85	4.0
Chest Pain Unspecified	77	3.6
Cardiac Ischemia w/o MI	75	3.5
Cardiac Dysrhythmia	56	2.6
GI Bleed	48	2.2
Anxiety	33	1.5
Bronchitis	32	1.5
Neoplasm	30	1.4
UTI, Urosepsis	29	1.4
Pneumonia	27	1.3
Asthma	27	1.3
Gastroenteritis	25	1.2
Poison/Toxin	95	4 4
Other Medical	414	19.3
Unknown	29	1.4

TABLE 2

Non-traumatic Final Case Distribution

Text	Number of Occurrences	Percent
Cardiac Ischemia w/o MI	170	7.9
CHF	154	7.2
MI	152	7.1
Seizure Disorder	130	6.1
Syncope	127	5.9
Cardiac Arrest	120	5.6
Chest Pain Unspecified	111	5.2
Cerebrovascular Disease	103	4.8
COPD	97	4.5
Hypoglycemia	85	4.0
Cardiac Dysrhythmia	73	3.4
GI Bleed	49	2.3
Anxiety	35	1.6
Bronchitis	32	1.5
Neoplasm	30	1.4
UTI, Urosepsis	29	1.4
Pneumonia	29	1.4
Asthma	27	1.3
Gastroenteritis	26	1.2
Poison/Torin	96	4 5
Other Medical	433	20.2
Unknown	32	1.5

TABLE 3

ICD9 Class Rank by Age

Age	First	Second	Third
0-11	Symptoms/Signs	Poison/Injury	Respiratory Systems
12-17	Symptoms/Signs	Poison/Injury	Endocrine/ Metabolic
18-24	Symptoms/Signs	Poison/Injury	Pregnancy/Childbirth
25-34	Symptoms/Signs	Poison/Injury	Endocrine/Metabolic
35-44	Symptoms/Signs	Cardiovascular	Poison/Injury
45-54	Cardiovascular	Symptoms/Signs	Respiratory System
55-64	Cardiovascular	Symptoms/Signs	Respiratory System
65-74	Cardiovascular	Symptoms/Signs	Respiratory System
75+	Cardiovascular	Symptoms/Signs	Respiratory System

TABLE 4

Disease Associated With Greatest Mortality

	Cases	Deaths	Percent
Cardiac Arrest	120	114	95
Respiratory Failure	15	10	67
Neoplasm	30	10	33
Myocardial Infarction	140	38	27
GI Bleed	47	10	21
Cerebrovascular Disease	98	20	20
CHF	97	16	16

26% Cases 83% Deaths

INFORMATION REQUIREMENTS FOR EFFECTIVE DISASTER MANAGEMENT

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INTRODUCTION

Natural disasters such as earthquakes, cyclones, tsunamis, and volcanic eruptions have claimed about 3 million lives worldwide during the past twenty years, adversely affecting the lives of at least 800 million more people, and have resulted in property damages exceeding $23 billion. While past disasters have produced their share of massive casualty situations, the future appears to be even more bleak. Increasing population density in flood plains, seismic, and hurricane-prone areas, the development and transportation of thousands of toxic and hazardous materials, the potential risks that can occur from incidents at fixed-site nuclear and chemical facilities, and the catastrophic possibilities from massive fires and explosions, all point to the probability of large mass casualty occasions in the future. Recent catastrophes have included the Bhopal chemical accident in 1984, the Mexico City earthquake in 1985, the Chernobyl nuclear power plant accident in 1986, the Armenia earthquake and Hurricane Gilbert in 1988, and most recently, Hurricane Hugo (1989).

Because of these recent events, much international attention has become focused on the problem of effectively dealing with natural and technological disasters. The United Nations General Assembly has recently designated the 1990s as The International Decade of Natural Disaster Reduction (IDNDR), during which time a concerted international effort will be made by the world's scientific community to reduce the loss of life and damage of natural disasters.