Paramedic Programs and Cardiac Mortality: Description of a Controlled Experiment

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A PROLIFERATION OF EMERGENCY MEDICAL SERVICES (EMS) has occurred throughout the United States during the past decade. The heightened interest in EMS programs has been manifested in the training of thousands of emergency medical technicians (EMTs) and paramedics, the creation of residencies in emergency medicine, generous Federal and foundation financial support, and the dramatic popularization of EMS in the media. However, in EMS, as in many nascent health care programs, evaluation of the effectiveness of services has lagged behind the development and implementation of programs.

Thus, documentation as to whether paramedic programs actually achieve their ultimate goals of reducing morbidity and mortality from medical emergencies is poor. The paucity of outcome studies designed to evaluate the impact of EMS on medical emergencies has made it difficult for health care professionals and public officials to assess the benefits of paramedic programs and to allocate scarce resources rationally. We describe a study (Project Restart) being conducted in King County, Wash., that will provide comparative data on the effect of paramedic programs on cardiac mortality.

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Criteria for Outcome-Evaluation Studies

If the impact of paramedic programs on outcome for the patient is to be properly evaluated, certain criteria must be fulfilled.

Objectives. The conduct of a meaningful evaluation depends upon a clear statement of the program's objective or objectives. In the case of a paramedic program, it may be assumed—but should be clearly stated—that the primary objective is to reduce morbidity and mortality.

Control groups. A control group of patients not treated by paramedics is a necessary benchmark against which the outcome for patients treated by paramedics can be measured. Without the use of control groups for comparisons, it is impossible to determine whether outcomes are due to paramedic intervention or to extraneous factors.

A truly experimental design would dictate that patients be randomly assigned to treatment or control groups. In practice, however, such random assignment is difficult to imagine. Similarly, to assign adjacent communities randomly to control or treatment groups is not politically feasible. A realistic method is to study a community before and after paramedic intervention and to compare that community with control communities with similar characteristics. Such a method would be termed quasi-experimental.

Case definition. Precise definitions of the cases that

are to be included in the study sample are necessary if treated and control groups are to be compared. Of the numerous types of medical emergencies that have been suggested for evaluations of outcome, cardiac arrest caused by heart disease seems the most appropriate. Heart disease is the leading cause of death in adults in the United States (*1*), and of the 600,000 deaths annually in this country due to it, an estimated two-thirds occur suddenly, outside of hospitals. Many of the deaths are a result of ventricular fibrillation, an event that may be definitively identified in the field and reversed by emergency intervention (*2,3*). Efforts to study other emergencies, such as trauma, have been unsuccessful because of the difficulties in defining cases and in validating the measurement criteria; moreover, in many types of trauma cases, intervention probably cannot alter the outcome (*4*).

Data collection method. In a study evaluating outcome, the data will generally have to be collected prospectively so that control can be exercised over collection procedures, such as the identification of cases and specification of the information being sought. Information routinely collected for administrative or other purposes is not likely to be adequate for an outcome evaluation. Furthermore, data should be collected for a sufficiently long period, generally at least for 1 year, to ensure that a representative sample of emergency medical incidents is surveyed and that seasonal variations can be discounted.

Adequate sample size. Outcome evaluation studies require an adequate sample of emergency medical incidents for two reasons. First, inclusion of a sizable number of incidents maximizes the likelihood of detecting significant differences. Second, the sample must be representative of the total emergency medical incidents of the particular type occurring in the community.

Background

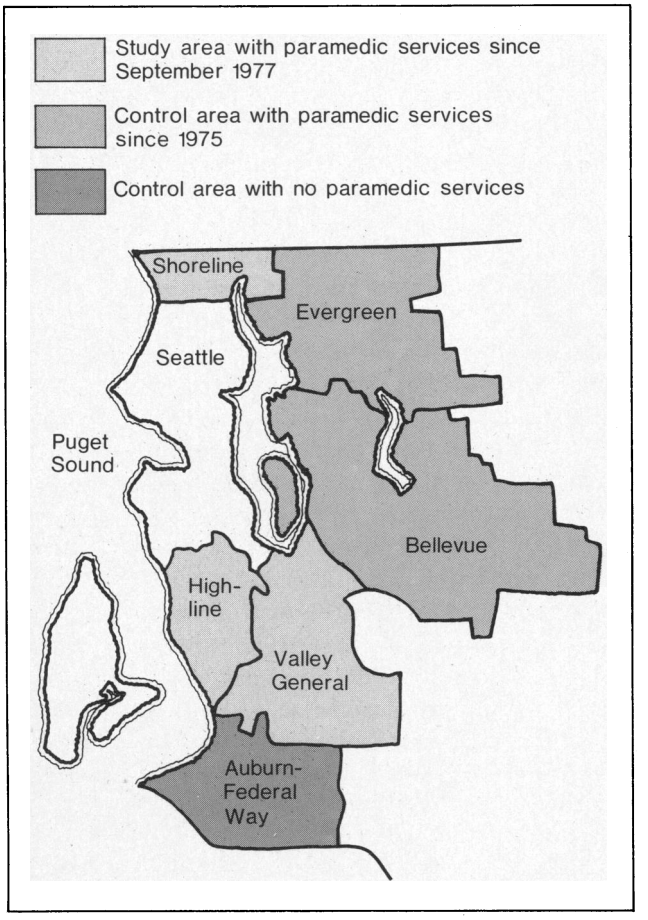
An outcome-evaluation of paramedic services incorporating the major criteria for such evaluations set forth in the preceding paragraphs began in King County, Wash., in April 1976. King County, of which Seattle is the county seat, is the most populous county in the State (1,164,000 in 1977). In 1975 the King County Council began appropriating approximately $1 million annually to establish and operate a countywide paramedic program in its suburban areas. Suburban King County (population 598,000) was to be divided into six paramedic service areas on the basis of political subdivisions (county fire districts) and geography (see map), and paramedic services would be introduced into these areas incrementally.

Seattle has had a paramedic program in operation since 1970. The city's program, the well-known Medic-1, is based on the tiered response concept, and the King County paramedic program is patterned after Medic-1. Under the tiered response concept, the fire departments, which traditionally provide rescue and emergency medical services, staff their aid cars with firefighters trained to the level of emergency medical technician (EMT). Fire department aid units constitute the first level of response and are assisted, when appropriate, by paramedic units, the second level of response. Private ambulances play a relatively small role in primary emergency care.

Treatment and control groups. The 1975 decision of the King County Council to implement paramedic

programs incrementally offered an opportunity for a before and after study in one community, with two other communities serving as control groups (see map). The study community (population 293,000) first received paramedic services in September 1977. In the study community, the outcomes for cardiac arrest patients during the 17-month period before paramedic services began (April 1976–August 1977) are being compared with the outcomes in the 13-month period after the initiation of such services (September 1977–September 1978). A second community, which had independently established paramedic services in 1975, serves as a control area with paramedic services. A third community, which will not receive paramedic services until early 1979, serves as a control area without paramedic services. Demographic information collected from the Census Bureau and local governmental agencies indicates that residents of all three areas are similar in respect to age, sex, race, and the incidence of out-of-hospital cardiac arrest.

Suburban areas of King County, Wash., in which impact of paramedic services on cardiac mortality was studied, April 1976–September 1978



The way in which King County is implementing its paramedic programs helps reduce potential bias from intervening variables. For example, all paramedics receive identical training and operate under identical standing orders. Thus, emergency conditions will be diagnosed and treated in a consistent manner. Furthermore, because the program is funded and coordinated by a single county agency, access to information for study purposes is assured.

Case definition. The patients selected for the study, who may be of any age, must have received cardiopulmonary resuscitation (CPR) secondary to circulatory arrest that has occurred outside a hospital in a nontraumatic situation. Patients must have evidenced a pulseless condition before CPR was administered, and a paramedic or EMT must have confirmed the lack of a carotid or femoral pulse. The criteria for initiation of CPR are based upon the American Heart Association's Basic Cardiac Life Support Standards. In a majority of instances, an ECG (electrocardiagram) rhythm strip is taken, documenting the cause of cardiac arrest. These rhythm strips are taken by paramedics, using their defibrillator equipment, or by EMTs with portable ECG monitors, which were specially provided for the study.

Case identification and data collection. Cardiac arrest patients who have received CPR are identified through a three-part system of surveillance of all the public and private agencies that respond to medical emergencies in the county. The principal surveillance tool is a brief questionnaire, which all suburban fire departments, paramedic programs, private ambulance companies, and county police complete following a CPR incident. Identifying information about the patient is collected, as well as data on the time required to contact the emergency agency, the time it took the agency to respond, the time from patient's collapse to initiation of CPR, the time from patient's collapse to administration of definitive care (defibrillation and other emergency procedures), whether the cardiac arrest was witnessed, the type of personnel initiating CPR, and the patient's cardiac rhythm.

The second part of the surveillance system consists of medical incident report forms. These forms are submitted to the county funding agency by 95 percent of the local fire districts. The third part of the surveillance system consists of lists kept by all suburban hospitals on patients who have received CPR. We believe this redundant surveillance system provides 100 percent identification of the cardiac arrest patients for whom resuscitation has been attempted. After the CPR patients are identified, the initial outcome of their cases,

either death or hospital admission, is determined. Admitted patients are followed to determine if they have been discharged and to check their survival status 6 months after discharge. In addition, cardiac arrest patients are classified by etiological category (such as primary heart disease, cancer, sudden infant death syndrome), based upon information from hospital record rooms, attending physicians, autopsy reports, and death certificates.

Sample size. Data for the study are to be prospectively collected over a period of 30 months on an estimated 1,000 cardiac arrests. Thus, the criteria for data collection set forth earlier in this paper will be fulfilled.

Discussion

We surveyed other studies on the outcome of paramedic programs to find a basis for comparison with the King County study. Only articles that had been published in U.S. scientific journals since 1970 and that described how paramedic programs affected morbidity and mortality from cardiac arrest were examined. Also, only studies presenting data on 25 or more patients were considered.

All the programs surveyed had initiated emergency mobile units recently, and all these units were staffed by highly trained paramedics (or MDs or RNs) who were capable of resuscitating patients experiencing ventricular fibrillation (VF) outside a hospital. Studies in which the outcome (morbidity or mortality) for cardiac arrest patients was examined have been reported from Seattle (*5,6*), Miami (*7,8*), Los Angeles (*9,10*), and Charlottesville (*11*).

Seattle. The largest series of cardiac arrest patients was reported by Cobb in a study of the Seattle Medic-1 program (*5*). The study was essentially descriptive; outcomes (death or discharge) were documented for all cardiac arrest patients with VF. There was no control group. In the first 51 months of operation of the Seattle Medic-1 program (1970–74), 1,106 patients with ventricular fibrillation were treated, of whom 234 (21 percent) were resuscitated, hospitalized, and discharged. Survival 4 years after cardiac arrest was determined to be 40 percent of all patients discharged (8.5 percent of the total 1,106). Increases in the percentage of discharged patients (11 percent in the first and second years and 23 percent in the third and fourth) were attributed to improved first-level response and increased initiation of CPR by bystanders. Cobb and co-workers reported that the percentage of patients with VF due to myocardial infarction who survived was higher than the percentage of VF patients without myocardial infarction (*5,6*).

Miami. In another descriptive study, the outcomes for a large series of patients in Miami who experienced ventricular fibrillation outside of a hospital were reported (*7,8*). Data were collected for 42 months on cardiac arrest patients experiencing VF. Of the 301 such patients experiencing it, 42 (14 percent) survived to be discharged. The time from collapse to initiation of defibrillation was considerably longer in Miami (average 15.1 minutes) than in Seattle (average 7 minutes); the Miami patients were also on the average 3 years older than the Seattle patients. The mean survival time of Miami patients after hospital discharge was 13 months. No control population was used.

Los Angeles. There were fewer patients in the studies in Los Angeles and no control groups. In one study, Graf and co-workers reported that of the 186 patients involved in resuscitation efforts for cardiac emergencies in Los Angeles County from 1969 to 1972, 35 (19 percent) were subsequently discharged (*9*). These authors compared the outcome for patients in respect to diverse EMS factors, such as the care given by coronary care unit nurses as contrasted with care given by paramedics and the use of mobile coronary care units as contrasted with use of ordinary ambulances. No significant differences in outcome were detected. In a more recent study, Diamond and co-workers reported that of 120 cardiac arrest patients in Los Angeles treated by paramedics from July 1974 through May 1975, 13 percent were discharged from the hospital (*10*).

Charlottesville. The last study of outcome that we considered was conducted in Charlottesville, Va. It differs from the others in that Crampton and co-workers attempted to compare cardiac mortality in their community in the period before the establishment of an emergency cardiac program (1966–70) and the period after its establishment (1971–73). When out-of-hospital defibrillation was not available, no lives were saved in 83 attempted resuscitations. From 1971–73, however, a mobile coronary care unit staffed by emergency room physicians and nurses was dispatched from the hospital to treat persons reportedly experiencing VF. In this later period, of 46 persons for whom resuscitation was attempted, 20 were admitted to the hospital and 12 "resumed active life" (*11*).

The kinds of medical emergencies in the Charlottesville study were not defined precisely except that three of the "saved" patients were believed to have experienced noncoronary episodes and presumably did not have heart disease. The authors' statement that the mortality rate in the community had declined as a result of the new program is marred not only by an

imprecise definition of cases, but also by the fact that cardiac mortality throughout the nation was declining before initiation of the paramedic program (*12,13*). The Charlottesville study, although descriptive and not experimental in design, is nevertheless the first published attempt to relate mobile coronary care units to a community's cardiac mortality.

In summary, as the following table shows, none of the studies surveyed fulfilled all the specified criteria for an outcome evaluation of a paramedic program.

Study area	*Control groups*	*Data collection methods*	*Adequate sample size*	*Precise case definition*
Seattle	0	+	+	+
Miami	0	+	+	+
Los Angeles	0	+	+	+
Charlottesville ..	0	0	+	0

NOTE: + = criteria met; 0 = criteria not met.

The major deficiency of the studies from all four areas of the United States was the lack of a control population—a deficiency that precludes a conclusive statement about the relationship of paramedic intervention to cardiac mortality. Unless treated and nontreated groups can be compared, a reduction in mortality cannot be independently attributed to a paramedic program. In contrast, the study being conducted in King County, Wash., incorporates a before and after design, and control groups are used. This study adequately fulfills the criteria for data collection, study method, sample size, and definition of cases that we discussed earlier. In the King County study, we will be able to quantify differences in outcome of cardiac arrest in patients from areas with and without paramedic services. In addition, such factors as the length of time before initiation of CPR and the type of personnel initiating CPR can be correlated with the outcome for the patients in terms of morbidity and mortality.

References

1. Gillum, R. F., et al.: The prehospital phase of acute myocardial infarction and sudden death. 1. Prodromata of acute coronary events. Prev Med 5: 408–413, September 1976.
2. Pantridge, J. F., and Geddes, J. S.: A mobile intensive-care unit in the management of myocardial infarction. Lancet 2: 271–273, Aug. 5, 1967.
3. Cobb, L. A., Conn, R. D., Samson, W. E., and Philbin, J. E.: Prehospital coronary care: the role of a rapid response mobile intensive coronary care system. Circulation 43 (supp. 2): 139 (1971).
4. Gibson, G.: Indices of severity for emergency medical evaluative studies: reliability, validity, and data requirements. Int J Health Serv. In press.
5. Cobb, L. A., Baum, R. S., Alvarez, H., 3d, and Schaffer, W. A.: Resuscitation from out-of-hospital ventricular fibrillation: 4 years follow-up. Circulation (supp. 3) 52: 223–228 (1975).
6. Baum, R. S., Alvarez, H., and Cobb, L. A.: Survival after resuscitation from out-of-hospital ventricular fibrillation. Circulation 50: 1231–1235, December 1974.
7. Liberthson, R. R., Nagel, E. L., Hirschman, J. C., and Nussenfeld, S. R.: Prehospital ventricular defibrillation: prognosis and follow-up course. N Engl J Med 291: 317–321 (1974).
8. Nagel, E. L., Liberthson, R. R., Hirschman, J. C., and Nussenfeld, S. R.: Emergency care. Circulation (supp. 3) 51 and 52: 216–218, December 1975.
9. Graf, W. S., Polin, S. S., and Paegel, B. L.: A community program for emergency cardiac care: a three-year coronary ambulance-paramedic evaluation. JAMA 226: 156–160 (1972).
10. Diamond, N. J., Schofferman, J., and Eliott, J. W.: Factors in successful resuscitation by paramedics. J Am Coll Emerg Phys 6: 42–46, February 1977.
11. Crampton, R. S., et al.: Amelioration of prehospital and ambulance death rates from coronary artery disease by prehospital emergency cardiac care. J Am Coll Emerg Phys, pp. 19–23, January–February 1975.
12. National Center for Health Statistics: Monthly Vital Statistics Report, Vol. 25, No. 11, February 1977.
13. Recent trends in mortality from ischemic heart disease. Stat Bull Metropolitan Life Ins Co 57: 10 (1976).

SYNOPSIS

EISENBERG, MICKEY S. (King County, Wash., Emergency Medical Services), and BERGNER, LAWRENCE: *Paramedic programs and cardiac mortality: Description of a controlled experiment. Public Health Reports, Vol. 94, January–February 1979, pp. 80–84.*

A quasi-experimental study of paramedic services that is underway in King County, Wash., fulfills selected criteria for evaluation of the outcome (morbidity, mortality) of patients' cases, including the use of controls and a study sample of adequate size. In the study, which is prospective and will cover 30 months, cardiac mortality from out-of-hospital cardiac arrest in a community of 293,000 population is being compared before and after the initiation of paramedic services. Two adjacent communities, one with paramedic services (population 217,000) and one without (population 84,000), act as controls. All three communities are similar with respect to age, sex, race, and incidence of out-of-hospital cardiac arrest.

A review of studies in four different areas of the United States concerning the impact on cardiac mortality of paramedic programs was undertaken to find a basis for comparison with the King County study. However, no quantitative statements could be made about the impact of any of the four programs because of the lack of control groups.