# Paramedic Programs and Out-of-Hospital Cardiac Arrest: II. Impact on Community Mortality

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**Abstract:** Out-of-hospital cardiac arrest was studied in suburban King County, Washington in an attempt to determine the impact of paramedic services on community cardiac mortality. A portion of the study area received paramedic services and the remainder received basic emergency medical technician (EMT) services. A surveillance system identified all prehospital cardiac arrest incidents. The etiology and outcome were determined. Deaths due to primary heart disease (ICDA codes 410–414) were compared to community cardiac mortality figures for the same period of time and in the paramedic and EMT areas.

Between April 1, 1976 and August 31, 1977, 1,449 deaths due to primary heart diesase occurred (annual rate of 19.2/10,000 in the EMT area and 13.4/10,000 in the paramedic area). For the same period, 487 patients with out-of-hospital cardiac arrest received emergency resuscitation. The annual incidence of out-of-hospital cardiac arrest was similar in the EMT and paramedic areas (5.6 and 6.0/10,000 respectively). Proportionately more lives of persons with cardiac arrest were saved in the paramedic area than in the EMT area. During this 17 month period, the reduction in community cardiac mortality was 8.4 per cent in the paramedic area and 1.3 per cent in the EMT area. These findings suggest that paramedic services have a small but measurable effect on community cardiac mortality. (Am. J. Public Health 69:39–42, 1979.)

Despite a series of case reports of lives saved as a result of paramedic programs,[1–3] there have been no convincing studies relating paramedic services to a reduction in community cardiac mortality.[4] This paper presents the findings of part of an outcome evaluation of paramedic programs which includes the parameter of community cardiac mortality.

Paramedic programs (also called mobile intensive care unit programs), provide a service whereby highly trained individuals can administer definitive procedures such as defibrillation, endotracheal intubation, and parenteral cardiac medications for out-of-hospital cardiac arrest (paramedic programs usually provide a full range of emergency services but here we consider only the most dramatic of these services, resuscitation from cardiac arrest). In contrast to paramedic programs, emergency medical technician (EMT) programs utilize EMTs trained in a standard 80-hour course. EMTs can perform cardiopulmonary resuscitation (CPR) but are unable to provide definitive care.

## *Methodology*

The study was known locally as Project Restart and is described in detail elsewhere.[5] The study was limited to the suburban area around Seattle with a population of 598,000 in 454 square miles. The period of study was from April 1, 1976 through August 31, 1977. During this period, part of the area (population 380,000) received emergency medical technician services and the remainder (population 218,000) received paramedic services. Seven community hospitals served the entire area, five in the EMT service area and two in the paramedic service area. All hospitals had coronary care units and 24-hour staffed emergency rooms.

Information was obtained through special reports submitted by both the paramedic and EMT services. A case of cardiac arrest was defined as a patient with a pulseless condition (confirmed by an EMT or paramedic) who received CPR. The criteria for initiation of CPR were identical in both parts of the study area: all emergency agencies follow American Heart Association standards for determining cardiac arrest.[6] Only out-of-hospital cardiac arrests and only cardiac arrests resulting from primary heart disease* are included in this study. Length of hospitalization was determined for all cases admitted to hospital. A cardiac arrest case, counted as one where life was saved, must have been admitted to a hospital, discharged, and survived until termination of the study period. At the close of the 17-month observation period, the longest follow-up was 16½ months, the shortest one-half month. The average period of follow-up was 8.8 months (9.6 and 8.5 months in EMT and paramedic areas respectively). The rhythm causing the cardiac arrest was documented for all survivors.

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*Etiology was determined from autopsy records, death certificates and, in the event of survival, clinical records.

For purposes of this study, heart disease deaths were defined as deaths due to ischemic heart disease, acute myocardial infarction, chronic ischemic heart disease, (ICDA codes 410–414). Community heart disease mortality for the same categories in the same areas as the study and for the same period was provided by the Vital Statistics Section of the Seattle-King County Department of Health. Population estimates for calendar year 1976 were derived by the Urban Data Center at the University of Washington and were aggregated by census tracts to coincide with the geographic area of the study. The Urban Data Center uses building and demolition permits, vacancy rates, and other indices to derive census tract population data for non-census years.

## *Results*

During the 17-month study period, there were a total of 1,449 deaths due to primary heart disease (ICDA codes 410–414) in the total study area (annual mortality rate 17.1/10,000). The average age was 70 for both sexes combined, 66 for men, and 76 for women. The majority (59 per cent) were men. The age distributions of primary heart disease deaths in the EMT and paramedic areas were virtually identical (see Figure 1).

During the same 17-month period, 487 out-of-hospital cardiac arrests due to primary heart disease were reported. The annual out-of-hospital cardiac arrest rate was similar in the EMT and paramedic areas, 5.6 and 6.0/10,000 respectively. Seventy-five per cent of the arrest cases were men. The average age of arrest cases was 65 for both sexes combined, 63 for men and 70 for women. The age distribution (Figure 2) in the two areas was slightly dissimilar. A greater proportion of arrests occurred in persons 80 years of age and older in the paramedic area (19 per cent) than in the EMT area (11 per cent). Comparing the age distribution of primary heart disease deaths (Figure 1) to the distribution of cardiac arrest (Figure 2), it is apparent that out-of-hospital cardiac arrest occurs more frequently among young persons dying of primary heart disease than it does among older persons who die.

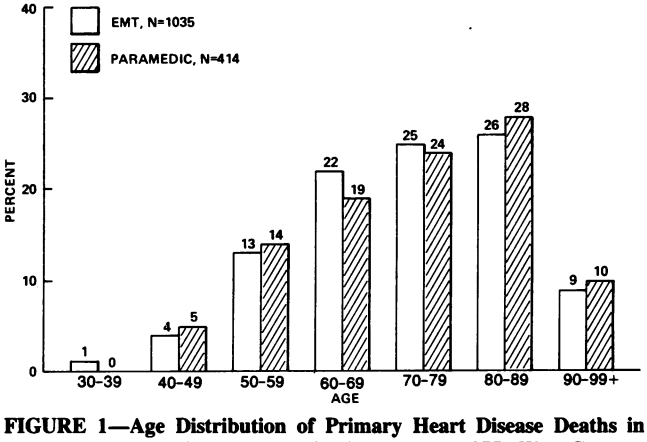


**FIGURE 1—Age Distribution of Primary Heart Disease Deaths in EMT and Paramedic Areas, April 1976–August 1977, King County, Washington**

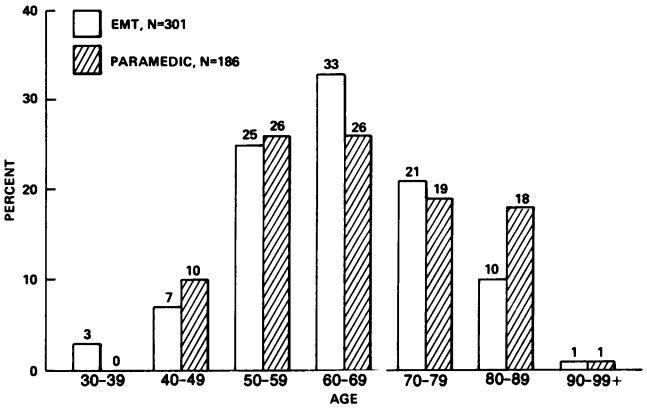


**FIGURE 2—Age Distribution of Out-of-Hospital Cardiac Arrest Due to Primary Heart Disease in EMT and Paramedic Areas, April 1976–August 1977, King County, Washington.**

Emergency medical technicians attempted resuscitation on 301 cardiac arrest patients in the EMT area. Of these patients, 14 (4.7 per cent) were discharged from hospital and were alive at the end of the study period. In the paramedic areas, 186 cardiac arrest patients were treated by paramedics; 38 patients (20.4 per cent) were discharged from hospital and alive at the end of the study period (chi square $p > 0.01$).

Of the 14 EMT area survivors, 13 had ventricular fibrillation and one had ventricular tachycardia. Of the 38 paramedic area survivors, 32 had ventricular fibrillation, five had ventricular tachycardia, and one had asystole as the rhythm precipitating cardiac arrest. All patients with ventricular tachycardia had lack of palpable carotid pulse and all were countershocked (the single EMT area patient was countershocked in an emergency room after ongoing CPR during transport). The single patient with asystole received intracardiac epinephrine but was not countershocked.

In the EMT area the average time to initiation of CPR was 3.9 minutes, compared to 3.7 minutes in the paramedic area. Citizens initiated CPR in 20 per cent of the cardiac arrests in the EMT area and in 27 per cent of the cardiac arrests in the paramedic area. The average time to definitive care (defined as availability of defibrillation and other advanced procedures) was 27 minutes in the EMT area, and eight minutes in the paramedic area. In the EMT area the average length of hospitalization for all admitted patients was 13.6 days; 10 per cent of the admitted patients died within six hours. In the paramedic area, hospitalization for all admitted patients averaged 13.4 days and 7 per cent died within six hours. Further details have been described elsewhere.[7]

As shown in Table 1, the per cent reduction in heart disease mortality was 1.3 per cent in the EMT area and 8.4 per cent in the paramedic area. Using the supplementary data we collected, we can state that in the absence of successful resuscitation there would have been 14 more heart disease deaths in the EMT area, while in the paramedic area there would have been 38 more deaths. The effect on annual community heart disease mortality would have been an in-

**TABLE 1—Rates of Primary Heart Disease Deaths, Cardiac Arrests, Lives Saved, and Reduction in Heart Disease Mortality, April 1976–August 1977, King County, Washington**

| | EMT | Paramedic | Total |
|---|---|---|---|
| Population | 379,769 | 217,913 | 597,682 |
| Primary heart disease deaths (annual rate/10,000 in parenthesis) | 1,035 (19.2) | 414 (13.4) | 1,449 (17.1) |
| Out-of-hospital cardiac arrests due to primary heart disease (annual rate/10,000) | 301 ( 5.6) | 186 ( 6.0) | 487 (5.75) |
| Lives saved (survivors) | 14 | 38 | 52 |
| Per cent lives saved (survivors/cardiac arrests) | 4.7% | 20.4% | 10.7% |
| Per cent reduction in heart disease mortality $\frac{\text{(lives saved)}}{\text{(heart disease deaths + lives saved)}}$ | 1.3% | 8.4% | 3.5% |

crease from 19.2 to 19.4 in the EMT area and 13.4 to 14.5 in the paramedic area.

The relative "benefit" (converse of risk) is computed at 4.4 (Table 2), meaning that an individual with out-of-hospital cardiac arrest was 4.4 times more likely to survive if care was given by paramedics. The potential or attributable "benefit" (converse of risk) of paramedic services is 16 per cent (Table 2), meaning that among 100 people with cardiac arrest in the EMT area, 16 additional individuals would have survived had paramedic services been available.

## *Discussion*

A basic assumption in this analysis is that without any emergency medical services, a patient experiencing out-of-hospital cardiac arrest would die. We think this is a reasonable assumption since cardiac arrest is fatal unless circulation can be restored within a few minutes. All patients included in our study had an absent pulse confirmed by an EMT or paramedic, and all had primary heart disease as the cause of their cardiac arrest.

Overall, 52 patients were resuscitated from cardiac arrest and survived until completion of the study period. All 52 had documented arrhythmias leading to cardiac arrest, the vast majority due to ventricular fibrillation, and all had heart disease according to their clinical records. Had these patients died, their death certificates would have been coded 410–414, and they would have contributed to the community heart disease mortality rate.

The differences in the proportion of cardiac arrest patient lives saved in EMT and paramedic areas is evident. In the EMT area, only 4.7 per cent (14) of the patients with cardiac arrest survived. Although CPR was initiated at the scene and continued during transport to the hospital emergency room, defibrillation occurred, on the average, 27 minutes after the collapse. In the paramedic areas, on the other hand, definitive care was provided at the scene of the cardiac arrest so that the average time from collapse to definitive care was much shorter (8 minutes) and 20.4 per cent (38) of the cases survived.

Although the shorter time to definitive care and greater survival of cardiac arrest patients in the paramedic area may explain part of the greater reduction in heart disease mortali-

**TABLE 2—Computation of Relative Risk**

| | Survival | | |
|---|---|---|---|
| | Yes | No | Total |
| Paramedic Area | 38 | 148 | 186 |
| EMT Area | 14 | 287 | 301 |

Relative "benefit": $\dfrac{\frac{38}{186}}{\frac{14}{301}} = 4.4$

Attributable "benefit": $\dfrac{38}{186} - \dfrac{14}{301} = 0.16 \times 100 = 16\%$

ty in this area when compared to the EMT area, the difference in mortality rate between the two areas (19.2–13.4 = 5.8/10,000) is greater than can be explained by the attributable benefit of paramedic services.‡ Possible explanations for this difference are age and sex differences, socioeconomic differences, reporting artifacts, hospital effects, and possible benefits from early treatment of myocardial infarction.

In this study it was not possible to standardize the rates of heart disease in the two areas by age and sex since denominator information was not available for census tracts in mid-census years. We believe, however, that differences in age and sex between the EMT and paramedic areas are not great. The age distribution of heart disease deaths was similar in the two areas and there were no sex differences. The paramedic area had a higher proportion of older people with cardiac arrest which would place successful resuscitation at a disadvantage.

Socioeconomic differences between the paramedic and EMT populations could possibly explain the difference in survival rates. Although both area populations are over 98 per cent Caucasian with virtually no poverty present, the paramedic area is slightly higher in terms of median income, housing valuation, and educational attainment. A recent study of heart disease mortality in suburban communities suggests differences based upon socioeconomic parameters.[8]

Another possible explanation for differences in community mortality is reporting artifact. More specialists practice in the paramedic area, and this might result in a better appraisal of cause of death. To our knowledge, differentials in death certificate classification between specialists (internists, cardiologists) and general practice physicians have not been studied.

Differences in hospital services could theoretically explain differential survival rates. Average lengths of stay were similar, and the same percentage of admitted patients died within six hours in both areas. All seven hospitals have full time emergency personnel and all have coronary care units. Nevertheless, hospital effects were not specifically studied and cannot be discounted.

Finally, it is possible that paramedic programs not only reduce sudden death, but result in a reduction of cardiac mortality because of the earlier treatment of myocardial infarction. In addition to treating cardiac arrest, paramedics are able to diagnose suspected myocardial infarction and initiate out-of-hospital care, such as the administration of analgesics and the treatment of arrhythmias with lidocaine or other antiarrhythmic drugs; such early treatment could result in a lower overall mortality rate from myocardial infarction.

The above explanations for the observed differences in heart disease mortality can ot be discounted and each may play some role in explaining our findings. We intend to continue these studies and to compare mortality rates after paramedic services are initiated in the EMT area.

Keeping in mind the limitations which we have described, our findings at this point suggest that, in suburban King County, an area in which CPR administered by citizen bystanders is more widespread than elsewhere in the county,* EMT services may reduce community heart disease mortality by approximately 1 per cent while paramedic services may reduce such mortality by approximately 8 per cent. A larger number of cases will enable us to employ multivariate analytic methods to control for more variables, and continuing experience will allow us to determine whether these initial findings can be sustained.

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‡Assuming paramedic services were available in the EMT area, the computed attributable "benefit" suggests that the resulting community heart disease mortality rate would have been 18.4/10,000.

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