# RECENT TRENDS IN ACUTE CORONARY HEART DISEASE

## Mortality, Morbidity, Medical Care, and Risk Factors

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**Abstract** *Background.* Mortality from coronary heart disease (CHD) has declined in the United States since the late 1960s. To understand the reasons for the decline during the period from 1985 to 1990, we examined trends in mortality and morbidity due to CHD, medical care, and risk factors for CHD in a large metropolitan population.

*Methods.* We identified all deaths from CHD in residents of the Minneapolis–St. Paul, Minnesota, metropolitan area who were 30 to 74 years old and classified the deaths according to whether they occurred in or out of the hospital. For 1985 and 1990, we obtained lists of patients in this age range who were discharged with a diagnosis of acute CHD from all area hospitals, and we selected the medical records of 50 percent of these patients for abstraction. Definite myocardial infarctions were identified with a standardized diagnostic algorithm. The 1985 and 1990 cohorts of patients hospitalized for myocardial infarction were followed for at least three years to identify those who died from any cause. Trends in risk factors for CHD were investigated through surveys of 25-to-74-year-olds that were conducted in 1985 through 1987 and 1990 through 1992.

*Results.* Between 1985 and 1990, mortality from CHD fell by 25 percent for both men and women, and the decline in in-hospital mortality (41 percent) exceeded the decline in out-of-hospital mortality (17 percent) among men. The rates of hospitalization for acute myocardial infarction declined slightly, by 5 to 10 percent, between 1985 and 1990. Survival among patients hospitalized for acute myocardial infarction increased substantially during that period. After adjustment for age and previous myocardial infarction, the relative risk of dying within three years of hospitalization for a myocardial infarction (for the 1990 cohort as compared with the 1985 cohort) was 0.76 for men (95 percent confidence interval, 0.65 to 0.89) and 0.84 for women (95 percent confidence interval, 0.71 to 1.00). Substantial increases in the use of thrombolytic therapy, heparin, aspirin, and coronary angioplasty paralleled the survival trends. In general, the risk-factor profile of the area population with respect to CHD also improved considerably during that time.

*Conclusions.* The recent decline in mortality due to CHD in the Minneapolis–St. Paul metropolitan area can be explained by both the declining incidence of myocardial infarction in the population and the improved survival of patients with myocardial infarction. (N Engl J Med 1996;334:884-90.)



RATES of mortality from coronary heart disease (CHD) in the United States, adjusted for age, have declined since the mid-1960s.[1] During the 1980s, the annual rate of that decline was about 3.5 percent for both men and women.[2] CHD nonetheless remains the leading cause of death in the United States, claiming the lives of 489,171 Americans in 1990.[3]

Many factors have probably contributed to the decline in mortality due to CHD that is evident in official statistics, including reduced levels of risk factors for CHD in the general population; declining incidence and perhaps severity of disease[4]; changes in medical care,[5,6] which may influence survival; a reduction in the number of people with chronic CHD, which in turn lowers the rate of recurrent acute myocardial infarction; and finally, artifacts such as changes in coding of causes of death on death certificates[7,8] or in hospital reimbursement rules.[9] The relative contributions of each of these factors to the decline in mortality due to CHD have not been well documented. Several reports have indicated that changes in both the incidence of myocardial infarction[10] and the rate or length of survival after myocardial infarction[11-13] probably played a part in the decline in mortality due to CHD in the 1970s and the early 1980s, but little is known about more recent trends.

The Minnesota Heart Survey has examined the trends in mortality and morbidity due to CHD, medical care, and the risk-factor profile with respect to cardiovascular disease in the second half of the 1980s. The study population comprised all residents 30 to 74 years of age in a large metropolitan area: Minneapolis–St. Paul, Minnesota, and the surrounding suburbs.

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## METHODS

### Study Population and Data on Mortality

According to the U.S. Census Bureau, the seven-county metropolitan area of the Twin Cities of Minneapolis and St. Paul had a population of 2.29 million in 1990. In that year, the target population for this study (those 30 to 74 years old) consisted of 550,719 men and 576,690 women. The corresponding population in 1985 was estimated by log-linear interpolation from 1980 census data. The population of the Twin Cities metropolitan area is overwhelmingly white.

Deaths due to CHD (i.e., those for which CHD was the underlying cause of death) among residents of the Twin Cities area were defined as those designated by codes 410 through 414 of the *International Classification of Diseases, 9th revision, Clinical Modification* (ICD-9-CM)[14] (the codes for ischemic heart disease); such deaths were classified according to whether they occurred in the hospital or out of the hospital. Out-of-hospital deaths included those of persons who were listed as dead on arrival at the hospital or died in the emergency department.

A study of out-of-hospital deaths in the Twin Cities area found that the diagnosis of ischemic heart disease on the death certificate had a high level of sensitivity (90 percent) and a high positive predictive value (94 percent) for the actual presence of ischemic heart disease.[15]

### Data on Hospitalization for Acute CHD

For 1985 and 1990, we obtained lists of patients 30 to 74 years old who were discharged from hospitals in the Twin Cities metropolitan area with an ICD-9-CM code for acute CHD among the discharge diagnoses. The target ICD-9-CM codes were 410 (acute myocardial infarction) and 411 (other acute and subacute forms of ischemic heart disease). All 25 hospitals operating in 1990 and all 31 hospitals operating in 1985 provided the requested information. From these lists of patients, we randomly selected 50 percent samples of men and women in 1985 and a 50 percent sample of men in 1990. All women with a discharge code indicating acute CHD were included in the 1990 cohort.

The medical records of the selected patients were abstracted by trained nurses. Information was obtained on the patients' signs and symptoms, medical history, cardiac-enzyme levels, therapy, and (when available) autopsy results. Up to four electrocardiograms (ECGs) were photocopied and coded according to the Minnesota Code, a standardized method of scoring ECGs.[16]

To ensure standardized criteria for myocardial infarction over time, we applied a computer-based diagnostic algorithm to all abstracted records of hospitalizations for acute CHD in which autopsy findings, information on chest pain, Minnesota ECG codes, and peak cardiac-enzyme levels were included. An abnormal enzyme value was defined as a peak level of creatine kinase MB that was more than twice the upper limit of normal or peak levels of both lactate dehydrogenase and total creatine kinase that exceeded twice the upper limit of normal. Cases were classified by the diagnostic algorithm, primarily on the basis of peak enzyme values, into three categories: definite myocardial infarction, possible myocardial infarction, or no myocardial infarction; only patients with definite myocardial infarctions were included in this analysis. In addition, a physician reviewed and classified deaths that occurred within 48 hours of hospitalization whenever the patient was not classified as having definite myocardial infarction by the algorithm (n = 78). First and recurrent myocardial infarctions were distinguished by extensive searches of the patients' prior hospitalization records.

### Follow-up for Mortality

Each patient's vital status at the time of hospital discharge was ascertained from his or her medical record. Vital status after hospital discharge was determined by computer linkage with the Minnesota Death Index, a system that has 98 percent agreement with the National Death Index.[17] Information on deaths was available through 1993, allowing for the evaluation of three-year survival in all patients. Death due to any cause was considered the study end point.

### Surveys of Risk Factors in the Population

To estimate trends in the risk-factor profile of the Twin Cities population with respect to CHD during the same period, we conducted population-based surveys in 1985 through 1987 and 1990 through 1992. Details of the sampling and survey methods have been published elsewhere.[18] In brief, a cluster sampling design was used to select men and women 25 to 74 years old who were residents of the seven-county metropolitan area. Data on various demographic, behavioral, and physiologic characteristics were obtained by means of an interview conducted in the subjects' homes and a subsequent examination in a survey center. In each survey, 71 percent of all subjects of the designated ages who were initially contacted took part in the survey-center examination. Blood pressure was measured with a random-zero sphygmomanometer.

Serum total cholesterol was measured in nonfasting samples with an AutoAnalyzer II (Technicon Instruments, Tarrytown, N.Y.).[19] We estimated and adjusted for laboratory drift by remeasuring 400 samples from each of the two survey periods using the Abell–Kendall method. The estimated bias in the results was statistically significant in each survey period ($P<0.001$), indicating that the original measurements were a mean (±SD) of 8.5±0.5 mg per deciliter (0.22±0.01 mmol per liter) lower in 1985 through 1987 and 4.1±0.3 mg per deciliter (0.11±0.01 mmol per liter) higher in 1990 through 1992 than the true values. Serum thiocyanate, a biochemical marker of cigarette smoking, was measured by the method of Butts et al.[20] The Minnesota Leisure-Time Physical Activity questionnaire[21] was administered to a systematic subsample of 50 percent of the study subjects. The body-mass index was computed as the weight in kilograms divided by the square of the height in meters.

### Statistical Analysis

We computed several rates, all of which were person-based (i.e., we counted only one event per patient in a given year): the rate of acute CHD at hospital discharge (ICD-9-CM codes 410 and 411 combined), the rate of acute myocardial infarction at discharge (ICD-9-CM code 410), and the rate of acute myocardial infarction as the primary diagnosis at discharge (ICD-9-CM code 410 as the first listed diagnosis). Next, we computed the overall attack rate and rate of incidence of definite acute myocardial infarction among hospitalized patients. Finally, to take into account out-of-hospital deaths due to CHD, we combined such deaths with definite myocardial infarctions in hospitalized patients to obtain an overall estimate of the rate in the population.

Sex-specific rates were adjusted for age according to the age distribution of the U.S. population in 1980 by the direct method. The statistical significance of changes between 1985 and 1990 was assessed with use of Poisson regression.[22] Survival trends were evaluated by computing the relative risk of dying in 1990 as compared with 1985 after adjustment for age and a history of myocardial infarction.[23] The statistical significance of changes in acute medical care was determined by means of chi-square tests. Age-adjusted mean changes in risk-factor levels were estimated with standard mixed-model multiple regression methods, which took into account the cluster sampling design. All reported P values are two-tailed.

## Results

The total number of hospital discharges with codes for acute CHD (ICD-9-CM code 410 or 411) among Twin Cities residents who were 30 to 74 years old was 5568 in 1985 and 6574 in 1990. Of these, 59 percent involved ICD-9-CM code 410 in 1985 and 57 percent in 1990. About 30 percent of the total discharges were of female patients. In each year, approximately 75 percent of patients discharged with a diagnostic code of ICD-9-CM 410 and 12 percent of those with a code of 411 were classified by our algorithm as having had a definite acute myocardial infarction. The proportion with first myocardial infarctions remained constant between 1985 and 1990, at 64 percent. There were 853 out-of-hospital deaths due to CHD in 1985 and 751 in 1990, of which about 25 percent in each year occurred in women.

### Trends in Mortality Due to CHD

Trends in mortality due to CHD in the Twin Cities area from 1970 through 1990 are shown in Figure 1. Between 1985 and 1990, the age-adjusted rate of mortality due to CHD declined by approximately 25 percent in both sexes. That downward trend was observed for both in-hospital and out-of-hospital deaths. In men, however, in-hospital mortality due to CHD declined much more rapidly (at a rate of 9.9 percent per year) than out-of-hospital mortality (3.6 percent per year, $P<0.001$). Among women, both components of mortality due to CHD declined — between 5 percent and 6 percent per year in the second half of the 1980s. In-

hospital mortality declined much faster between 1985 and 1990 than between 1978 and 1985.

### Trends in Rates of Acute CHD

Trends in age-adjusted rates of acute CHD between 1985 and 1990 are shown in Table 1. The rate of discharge of patients with acute CHD listed as a diagnosis increased by 12 percent for men ($P<0.001$) but remained about the same for women. In contrast, the rate of discharge of patients with a diagnosis of acute myocardial infarction alone increased by only 3 percent for men ($P=0.40$) and decreased by 7 percent for women ($P=0.09$). When only patients with acute myocardial infarction as the first discharge code were considered, the rate of hospital discharge declined significantly, by 10 percent for men ($P=0.002$) and 11 percent for women ($P=0.03$). Although they were not statistically significant, trends among hospitalized patients with confirmed events (definite myocardial infarction) were also consistent with a slight decline in the rate of hospitalization for acute myocardial infarction between 1985 and 1990 (Table 1). The decline was larger (7 percent for both sexes) when we combined out-of-hospital deaths due to CHD with definite cases of acute myocardial infarction in hospitalized patients.

Table 1. Rates of Acute Coronary Heart Disease (CHD) among Residents of the Twin Cities Area, 30 to 74 Years of Age, in 1985 and 1990.*

| Variable | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | 1985 | 1990 | % change | 1985 | 1990 | % change |
| | *no./100,000* | | | *no./100,000* | | |
| Hospital-discharge diagnosis | | | | | | |
| Acute myocardial infarction or unstable angina | 900 | 1008 | +12† | 350 | 344 | −2 |
| Acute myocardial infarction | 573 | 590 | +3 | 204 | 189 | −7 |
| Acute myocardial infarction as first-listed diagnosis | 476 | 428 | −10† | 160 | 142 | −11‡ |
| Hospitalization for definite acute myocardial infarction | | | | | | |
| All events | 499 | 479 | −4 | 169 | 167 | −1 |
| First events | 315 | 298 | −5 | 111 | 107 | −4 |
| Recurrent events | 184 | 181 | −1 | 58 | 60 | +5 |
| Hospitalization for definite acute myocardial infarction or out-of-hospital death due to CHD§ | 656 | 613 | −7‡ | 218 | 203 | −7 |

*All rates were adjusted by the direct method to the age distribution of the total population of the United States in 1980. Acute myocardial infarction was indicated by ICD-9-CM code 410 and unstable angina by ICD-9-CM code 411.

†$P<0.01$ for the change from 1985 to 1990.

‡$P<0.05$ for the change from 1985 to 1990.

§Out-of-hospital deaths due to CHD were those for which ICD-9-CM code 410, 411, 412, 413, or 414 was listed as the underlying cause of death on the death certificates.

### Trends in Survival after Hospitalization for Acute Myocardial Infarction

Three-year survival curves for patients hospitalized for definite myocardial infarction showed substantial improvements in long-term survival among both men and women with acute myocardial infarction in the second half of the 1980s (Fig. 2). The risk of death both within 28 days and within 3 years was 15 to 25 percent lower in 1990 than in 1985, and improvements of similar magnitude were also evident among patients who survived the first 28 days (Table 2). In the latter group, the risk of death within three years decreased by 26 percent among men and 17 percent among women. Among men, but not among women, the survival trend was less evident for first myocardial infarctions than for recurrent cases, but the difference between the groups was not statistically significant ($P=0.08$). Among women, there was similar improvement in survival for first and recurrent myocardial infarctions. None of the relative-risk estimates differed significantly between men and women ($P\geq 0.20$). Patients hospitalized with acute myocardial infarction in 1990 who subsequently died within three years were less likely to have a diagnosis of cardiovascular disease as the underlying cause of death than their counterparts in the 1985 cohort (75 percent vs. 82 percent, $P=0.02$).

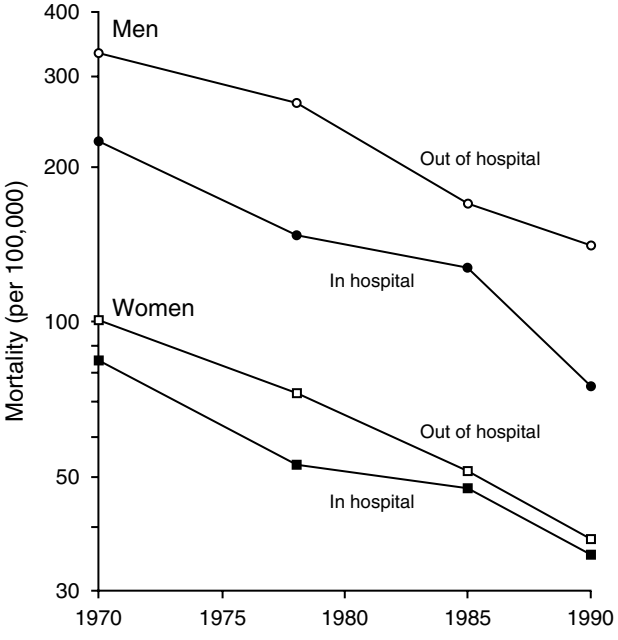


Figure 1. Trends in Mortality Due to Coronary Heart Disease from 1970 to 1990, According to the Location of Death, among Residents of the Twin Cities Area Who Were 30 to 74 Years of Age.

Mortality rates (shown on a logarithmic scale) have been adjusted by the direct method to the age distribution of the total U.S. population in 1980. Deaths in the emergency room and on arrival at the hospital are included as out-of-hospital deaths.

### Trends in Medical Care for Patients Hospitalized for Myocardial Infarction

Between 1985 and 1990, the median length of stay for patients with definite acute myocardial infarction in the Twin Cities area decreased from 8.5 days to 6.2 days among men and from 8.9 days to 6.9 days among women ($P<0.001$). There were substantial changes in the proportion of patients who were treated with selected surgical procedures or medications during their hospital stay (Fig. 3). The frequency of administration of throm-

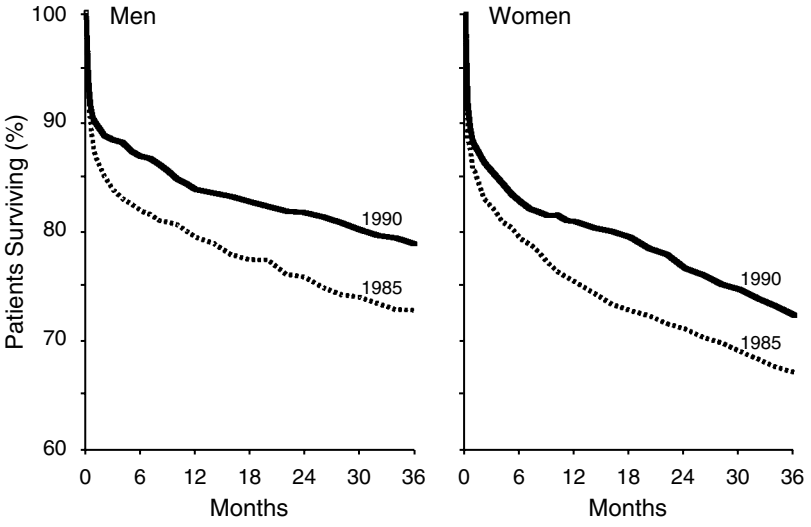


Figure 2. Trends in Survival in the Three Years after Hospitalization for Definite Acute Myocardial Infarction in 1985 and 1990 among Residents of the Twin Cities Area Who Were 30 to 74 Years of Age.

Survival has been adjusted to the age distribution of the patients in the Twin Cities area who were hospitalized in 1985 and 1990 for definite acute myocardial infarction.

bolytic therapy more than doubled (from 13 percent to 30 percent) during the period, and large increases were documented in the proportions of patients receiving coronary angioplasty (from 5 percent to 21 percent), aspirin (from 27 percent to 81 percent), and heparin (from 53 percent to 75 percent). In contrast, there were moderate, statistically significant declines in the use of warfarin (from 20 percent to 14 percent) and beta-blockers (from 56 percent to 50 percent), and little change in the use of bypass surgery (from 8 percent to 10 percent).

#### Contribution of Thrombolytic Therapy to Trends in Survival

We used two methods to estimate the contribution of thrombolytic therapy to the trends in survival among patients with acute myocardial infarction. First, we applied the estimated 19 percent reduction in 35-day mortality attributed to thrombolytic therapy[24] to the increase of 17 percentage points in the use of thrombolytic therapy in the Twin Cities area between 1985 and 1990. With that assumption, approximately 20 percent of the observed improvement in 28-day survival among patients hospitalized for acute myocardial infarction in 1990 might be attributable to the more frequent use of this therapy. Second, we used logistic-regression techniques to model the improvement in 28-day mortality among patients hospitalized for definite acute myocardial infarction, with adjustment for age, sex, systolic blood pressure, heart rate, presence or absence of diabetes, and history of myocardial infarction. The addition of a variable representing thrombolytic therapy to this model reduced the absolute magnitude of the effect of the year of hospitalization by 30 percent.

#### Trends in Risk Factors for CHD

The population-based surveys conducted by the Minnesota Heart Survey in 1985 through 1987 and 1990 through 1992 demonstrated a generally improved risk-factor profile with respect to CHD (Table 3). In particular, the mean serum total cholesterol concentration, prevalence and intensity of smoking, and mean systolic blood pressure all declined among both men and women. However, the level of physical activity changed little in either sex, and the body-mass index increased, although this change was not statistically significant. Aspirin use increased, primarily as a result of its increased use for the prevention of cardiovascular disease.

## Discussion

The decline in rates of mortality from CHD in the Twin Cities area during the 1970s and 1980s mirrored national trends. The decline, which began around 1968 and averaged 3.5 percent annually, accelerated during the late 1980s and totaled 25 percent between 1985 and 1990. This trend is particularly striking in view of the absence of any change in the rate of death from all noncardiovascular causes during the same period (data not shown).

In general, trends in the rate of out-of-hospital death from CHD probably reflect the success of primary-prevention measures; trends in in-hospital mortality from

Table 2. Mortality after Hospitalization for Definite Acute Myocardial Infarction among Residents of the Twin Cities Area, 30 to 74 Years of Age, in 1985 and 1990.*

| Variable | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | Mortality (%) | | RR (95% CI) | Mortality (%) | | RR (95% CI) |
| | 1985 | 1990 | | 1985 | 1990 | |
| 28-Day mortality† | 13 | 10 | 0.74 (0.58–0.96) | 15 | 12 | 0.84 (0.62–1.13) |
| 3-Year mortality† | 27 | 21 | 0.76 (0.65–0.89) | 33 | 28 | 0.84 (0.71–1.00) |
| 3-Year mortality among patients surviving to day 28† | 16 | 12 | 0.74 (0.58–0.94) | 22 | 18 | 0.83 (0.65–1.06) |
| 3-Year mortality among patients with a first myocardial infarction‡ | 21 | 18 | 0.85 (0.67–1.08) | 29 | 24 | 0.81 (0.63–1.03) |
| 3-Year mortality among patients with recurrent myocardial infarction‡ | 39 | 27 | 0.69 (0.56–0.85) | 41 | 36 | 0.88 (0.69–1.13) |

*RR denotes the relative risk of death (1990 vs. 1985), and CI confidence interval.

†Adjusted for age and history of myocardial infarction.

‡Adjusted for age.

CHD, in contrast, are more closely tied to advances in acute medical care. Between 1985 and 1990, the decline in in-hospital mortality in the Twin Cities area accelerated considerably and, at least for men, was greater than the decline in out-of-hospital mortality. Both findings suggest that medical care had a stronger effect than primary-prevention measures on trends in mortality due to CHD in the late 1980s.

Most measures of rates of hospitalization for acute myocardial infarction indicate a moderate decline between 1985 and 1990. Most of the decline occurred in the rate of first-time acute myocardial infarction; this decline was consistent with a concurrent favorable trend in the risk-factor profile of the general population, as reported here and elsewhere.[25-27] We are uncertain why the rate of discharge of patients with a diagnosis of acute CHD has increased among men whereas most other measures of trends with respect to acute myocardial infarction show declines. Two likely explanations are the introduction in the late 1980s of the ICD-9-CM code 410.x2 (with x representing a digit indicating the location of the infarct), used to identify a subsequent (nonacute) episode of care for patients with myocardial infarction, and the continued effects of reimbursement according to diagnosis-related groups.[9] Both had the potential to increase artifactually the proportion of discharges involving acute CHD as a diagnosis. It is unlikely that rates of hospitalization for acute CHD were actually increasing at a time of continued decline in mortality due to CHD.

There is a paucity of data on trends in rates of acute CHD in the late 1980s. A study in Worcester, Massachusetts,[10] which examined trends in the community up to 1988, found little change in the incidence of hospitalization for acute myocardial infarction between 1984 and 1988 among people less than 75 years of age, but there was some evidence of a decline in this rate among older persons. Data from the National Hospital Discharge Survey (NHDS)[28] on unvalidated, first-listed discharge diagnoses of acute myocardial infarction suggest that the rate of hospitalization for acute myocardial infarction declined somewhat between 1985 and 1990.[2]

Previous reports from the Minnesota Heart Survey[12,13] documented a substantial improvement in both short-term and long-term survival among patients hospitalized for definite acute myocardial infarction from 1970 to 1980, but no further improvement from 1980 to 1985. In this study we document substantially improved survival among patients hospitalized for acute myocardial infarction, a trend that had an important role in the continued decline in mortality due to CHD. Between 1985 and 1990, the risk of death within three years after hospitalization for acute myocardial infarction was reduced by 15 to 25 percent. Furthermore, among those who died, cardiovascular disease was less likely to be the underlying cause of death.

The trends in therapy for acute myocardial infarction that are documented in this study are evidence of the important role of acute medical care in the tendency toward lower mortality due to CHD. Two types of anal-

Table 3. Trends in the Risk-Factor Profile with Respect to Cardiovascular Disease among Residents of the Twin Cities Area, 25 to 74 Years of Age, in 1985 through 1987 and 1990 through 1992.*

| VARIABLE† | MEN | | WOMEN | |
|---|---|---|---|---|
| | 1985–1987 (N = 2713) | 1990–1992 (N = 2789) | 1985–1987 (N = 3022) | 1990–1992 (N = 3211) |
| Mean serum total cholesterol (mg/dl) | 208.4 | 203.3‡ | 203.8 | 200.0§ |
| Hypercholesterolemia (%) | 20.0 | 19.5 | 18.0 | 16.8 |
| Cigarette smoking (%) | 29.7 | 26.3§ | 27.8 | 25.5¶ |
| Mean serum thiocyanate ($\mu$mol/liter) | 71.2 | 62.2‡ | 63.1 | 56.0‡ |
| Mean no. of cigarettes smoked daily (by smokers only) | 22.8 | 20.0‡ | 18.5 | 16.6‡ |
| Mean systolic blood pressure (mm Hg) | 124.2 | 123.3¶ | 117.3 | 116.4¶ |
| Hypertension (%) | 24.4 | 25.7 | 21.6 | 18.0§ |
| Leisure-time physical-activity level per day (kcal) | 285.7 | 298.0 | 180.4 | 186.1 |
| Body-mass index | 27.0 | 27.2 | 25.9 | 26.2 |
| Aspirin use (%) | 11.4 | 17.4‡ | 12.9 | 15.6§ |

*Mean levels were adjusted for age.

†Hypercholesterolemia was defined as a serum total cholesterol concentration >240 mg per deciliter or current use of antihyperlipidemic medication; hypertension was defined as a systolic blood pressure ≥140 mm Hg, a diastolic blood pressure ≥90 mm Hg, or current use of antihypertensive medication; systolic blood pressure was adjusted for age, cuff size, use of antihypertensive medication, and room temperature. To convert cholesterol values to micromoles per liter, multiply by 0.02586.

‡P<0.001 for the comparison with 1985 through 1987.

§P<0.01 for the comparison with 1985 through 1987.

¶P<0.05 for the comparison with 1985 through 1987.

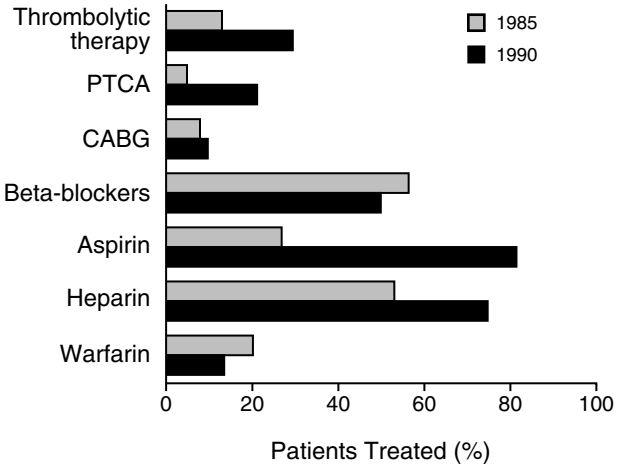


Figure 3. Trends in Acute Medical Care for Residents of the Twin Cities Area, 30 to 74 Years of Age, Who Were Hospitalized for Definite Acute Myocardial Infarction in 1985 and 1990.

PTCA denotes percutaneous transluminal coronary angioplasty, and CABG coronary-artery bypass grafting. The differences between 1985 and 1990 were statistically significant (P<0.05) in all cases except that of CABG. Information on aspirin therapy in 1985 was collected from a random 10 percent subsample of hospital records.

ysis suggest that approximately one quarter of the improvement in short-term survival after acute myocardial infarction may be attributable to more frequent use of thrombolytic therapy. The results of a study from Gothenburg, Sweden,[29] where there was also a large increase in the use of thrombolytic therapy during the late 1980s, are in agreement with these findings.

Other therapies with established effects on the survival of patients with myocardial infarction — such as aspirin[30] and anticoagulants[31] — were also used more frequently in 1990 than in 1985. Indeed, if the benefits of aspirin, in particular, can be assumed to approximate those reported in the Second International Study of Infarct Survival,[30] then the increase in aspirin use alone could have accounted for 50 percent of the observed decline between 1985 and 1990 in the short-term case fatality rate of patients hospitalized with acute myocardial infarction. Unfortunately, our data do not specify the timing of aspirin administration during the hospital stay, and it may be that much of the increased use of aspirin in 1990 was not intended as emergency care for evolving myocardial infarction. Although we did not collect data on the use of angiotensin-converting–enzyme inhibitors in 1985, 20 percent of patients with myocardial infarction in 1990 received such medication on discharge from the hospital.

Our finding of substantially improved survival among patients hospitalized for acute myocardial infarction is similar to the results reported by two other groups. The NHDS found a decline of about one third in the in-hospital case fatality rate for acute myocardial infarction between 1985 and 1990.[28] A similar trend was found in a population-based study in Ontario, Canada[32]; in that study there was little change in the case fatality rate among patients with myocardial infarction from 1981 through 1985, but survival improved substantially from 1985 to 1991. In contrast, a report from Worcester, Massachusetts, found an increase in the in-hospital case fatality rate for acute myocardial infarction between 1984 and 1988.[10] Recent trends in medical care for acute myocardial infarction, documented by the NHDS,[2,28] are similar to those reported here and elsewhere.[33,34]

Lower mortality among patients who survived to 28 days contributed to the overall improved survival of patients with myocardial infarction as much as did improvement in survival in the first 28 days (Table 2). Such improvement could be attributed to the more aggressive use of diagnostic and therapeutic procedures in the hospital or after discharge, or to greater emphasis on secondary-prevention measures (such as smoking cessation, lipid-lowering medications, dietary changes, and aspirin). It is also possible that the natural history of acute myocardial infarction has changed over time.

We conclude that the decline in mortality due to CHD among 30-to-74-year-old residents of the Twin Cities area in the second half of the 1980s can be explained by both the declining incidence of acute myocardial infarction in the population and the improved survival among patients with myocardial infarction. The decline in incidence is consistent with continuing improvements in the risk-factor profile with respect to cardiovascular disease, particularly smoking and high serum total cholesterol concentrations. The dramatic improvement in short-term survival among patients hospitalized for myocardial infarction probably resulted from the greater use of beneficial therapies, including thrombolytic agents, anticoagulants, and aspirin.

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