

Coronary Heart Disease Case Fatality in Four Countries

A Community Study

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Background. Community-based registers participating in the MONICA Project of the World Health Organization show markedly different attack and death rates of coronary heart disease. This variation is a function of both the incidence and case fatality occurring within countries. The contribution of case fatality to the international variation in coronary heart disease mortality rates is not well understood.

Methods and Results. The register data from eight study populations—Augsburg and Bremen in Germany, Auckland in New Zealand, Perth and Newcastle in Australia, and North Karelia, Kuopio, and Turku/Loimaa in Finland—were compared. All patients with definite myocardial infarction or coronary death aged 35 to 64 years occurring in the study populations in 1985 through 1989 are the basis for the case fatality calculations by different definitions: 28-day case fatality for all cases, for hospitalized cases, and for hospitalized 24-hour survivors; out-of-hospital case fatality; and 24-hour case fatality for hospitalized cases. Differences in case fatality were much smaller than differences in attack and mortality rates in these populations. About two thirds of deaths occurred before the patients reached a hospital. The 28-day case fatality ranged from 37% for men in Perth to 58% for women in Augsburg. Among those who reached the hospital alive, 28-day case fatality was 13% to 27% for men and 20% to 35% for women. In those who survived 24 hours from the onset of symptoms, 28-day case fatality was 8% to 17% for men and 12% to 26% for women.

Conclusions. Differences in case fatality were not associated with differences in coronary mortality rates between these populations. As most deaths occurred before reaching a hospital, opportunities for reducing case fatality through improved hospital care are limited. This emphasizes the primary role of prevention in reducing coronary death rates. (*Circulation*. 1993;88:2524-2531.)

KEY WORDS • heart disease • statistics • mortality

Coronary heart disease (CHD) mortality rates vary markedly among countries.^{1,2} This variation is a function of both the incidence and the case fatality occurring within countries. Although the variation in incidence is believed to be related to differences in risk factor levels,³⁻⁵ the contribution of case fatality to the international variation in CHD mortality rates is not well understood.

The WHO MONICA Project (Monitoring Trends and Determinants in Cardiovascular Disease) is a major international collaborative study designed to explain the trends and determinants of cardiovascular disease.⁶ It will collect data continuously on all suspected cases of acute myocar-

dial infarction (AMI) or coronary death over a 10-year period using population-based acute coronary event registers. The WHO MONICA manual allows a subset analysis of only six MONICA Collaborating Centers (MCC; Reference 7). In light of this rule, six MCCs were contacted that represent a wide range of CHD mortality and had coronary event registration data available for the time period of 1985 through 1989. Finally, eight study populations (MCC 26 in Augsburg and MCC 24 in Bremen, Germany; MCC 33 in Auckland, New Zealand; MCC 11 in Newcastle and MCC 10 in Perth, Australia; and MCC 20 in Finland including North Karelia, Kuopio,

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TABLE 1. Definitions of Coronary Heart Disease Case Fatality

		Numerator	Denominator
CF1	28-Day CF	G1 + G2 + G3	G1 + G2 + G3 + G4
CF2	28-Day CF for hospitalized cases	G2 + G3	G2 + G3 + G4
CF3	28-Day CF for hospitalized 24-hour survivors	G3	G3 + G4
CF4	Out-of-hospital CF	G1	G1 + G2 + G3 + G4
CF5	24-Hour CF for hospitalized cases	G2	G2 + G3 + G4

CF indicates case fatality; G1, out-of-hospital deaths before hospitalization; G2, patients who were hospitalized and died within the first 24 hours after onset of symptoms; G3, patients who were hospitalized and survived the first 24 hours but died within 28 days from onset of symptoms; and G4, those who survived 28 days.

and Turku/Loimaa) serve as the basis for this article. In the 1984 official mortality statistics, the age-standardized CHD mortality per 100 000 of these 35- to 64-year-old study patients ranged from 161 ± 21 in Perth to 374 ± 37 in Finland for men and from 27 ± 9 in Bremen to 68 ± 19 in Newcastle for women.²

On the basis of the 1985 through 1989 MONICA register data, cross-sectional comparisons are made of case fatality among these eight populations. The association of case fatality at various stages of the acute event with age, sex, and prior history of myocardial infarction is examined.

Methods

The registration methods used in each center have been described previously.⁸⁻¹¹ All suspected coronary events, including out-of-hospital coronary deaths before hospitalization in men and women in defined age groups are registered in a comparable way. For this study, events in persons aged 35 to 64 years are reported. The events are classified into one of the MONICA diagnostic categories of AMI¹² on the basis of typical acute symptoms (chest pain for more than 20 minutes), enzyme elevations (creatinine phosphokinase and/or lactate dehydrogenase and/or aspartate aminotransferase) more than twice the upper normal value within 72 hours after the onset of acute symptoms, and ECG changes evaluated by Minnesota coding from the first available ECG in the attack (or one immediately before), second and third ones on different dates from the first and each other, and the last available ECG for the admission.¹³ The case finding and the validation procedures in nonfatal cases in the six MCCs show no indications for biases.

For this cross-sectional comparison among MCCs, events in the following categories are used: (1) deaths satisfying the MONICA definitions for fatal definite AMI, fatal possible AMI, and fatal coronary events with insufficient information for further classification but with death certificate diagnosis of CHD (ICD-9 codes 410-414) and (2) nonfatal definite AMI according to the MONICA criteria.

For fatal events, necropsy findings and history of CHD are also diagnostic criteria for the MONICA diagnosis. A serious limitation for diagnostic classification of suspected AMI events is created by regional differences in legal constraints on access to information

about the decedents and on opportunities to contact their relatives, the certifying physicians, or other informants, especially in centers with low autopsy rates (Bremen and Augsburg). The consequence is that varying amounts of data on diagnostic criteria may be missing, especially for out-of-hospital deaths. Therefore, fatal cases with insufficient data (<1% to 3% in Finland and Auckland, 9% in Perth, and 18% to 28% in Newcastle, Augsburg, and Bremen) must be included for these comparisons⁸ since generally only 3% to 6% of the autopsied decedents were classified as "no AMI," and obviously the great majority of cases with insufficient data will be moved to a definite or possible AMI MONICA diagnosis.

In these centers, very few nonfatal events satisfying these criteria are treated out-of-hospital (one case in Kuopio, two cases each in Auckland and Newcastle, six in North Karelia, and eight in Turku/Loimaa). They were excluded from the case fatality analyses.

In all centers except the Finnish ones, all deaths that occurred in the emergency departments of the hospitals were counted as in-hospital deaths. In Finland, a small number of deaths occurring soon after arrival to ambulant emergency departments or community health centers were classified as out-of-hospital deaths. These cases, however, comprise only about 2% to 3% of all deaths in the Finnish centers. Thus, this difference in the ascertainment of the place of death does not cause any appreciable bias in the comparisons of case fatality rates by definitions used in this study.

Definitions of Case Fatality

Events can be classified into four groups: group 1 (G1), out-of-hospital deaths before hospitalization; group 2 (G2), patients who were hospitalized and died within the first 24 hours after onset of symptoms; group 3 (G3), patients who were hospitalized and survived the first 24 hours but died within 28 days from onset of symptoms; and group 4 (G4), those who survived 28 days. From these groups, five definitions of case fatality (CF1 through CF5) are derived (Table 1).

Events are classified as first or recurrent AMI using information about history of previous AMI. For every center, this information is available for almost all hospitalized cases, but for out-of-hospital deaths, it is missing for about 1% to 3% in Finland and Auckland; 17% to 25% in Augsburg, Perth, and Newcastle; and

TABLE 2. Study Population, Total Number of Events, and Numbers by Event Groups for 1985 Through 1989 for Men and Women Aged 35 to 64 Years From Eight Study Populations in the WHO MONICA Project

	Study Population In 1987	No. of Events 1985-1989	No. by Event Groups			
			Out-of-Hospital Deaths (G1)	Hospital Deaths <24 h (G2)	Hospital Deaths ≥24 h-28 d (G3)	28-Day Survivors (G4)
Men						
Augsburg	102 238	1521	500	154	107	760
Bremen	104 463	1844	488	206	148	1002
Auckland	141 403	2893	1123	147	146	1477
Perth	181 998	3421	900	133	201	2187
Newcastle	70 950	1877	547	98	127	1105
Turku/Loimaa	37 432	1002	368	49	98	487
Kuopio	47 799	1782	535	86	164	997
North Karelia	33 029	1384	485	87	96	716
Women						
Augsburg	104 977	332	132	39	26	135
Bremen	109 380	445	114	54	48	229
Auckland	144 308	788	267	53	79	389
Perth	179 807	800	219	49	81	451
Newcastle	70 462	638	149	49	60	380
Turku/Loimaa	40 400	201	59	18	30	94
Kuopio	47 431	330	59	25	43	203
North Karelia	31 653	280	65	23	28	164

37% in Bremen. Therefore, case fatality definitions CF1 and CF4 including out-of-hospital deaths are not differentiated in first and recurrent events, but they were reported only for all events together. For the other definitions of case fatality including only hospitalized cases, events with unknown history of previous AMI (<3% of events per center) are omitted from the calculations.

Age Standardization

Direct age standardization of the event rates and the mortality rates was done according to the procedures of the WHO MONICA project² using the truncated Segi world standard population weights 6, 6, 6, 5, 4, and 4 for the 5-year age groups from 35 to 39 through 60 to 64 years, respectively.¹⁴ These were calculated for each year from 1985 through 1989 and then averaged. Age-standardized case fatality was calculated using direct standardization for the 10-year age groups of 35 to 44, 45 to 54, and 55 to 64 years with weights of 1/11, 3/11, and 7/11 based on the age distribution of events for the WHO MONICA Project as a whole.

For example, the age-standardized CF1 for a center is given by $\sum w_i (d_i/e_i)$ where i is 1, 2, or 3 to indicate the age group, w_i is the weight, d_i is the number of deaths (G1+G2+G3) occurring in age group i for that center in the period 1985 through 1989, and e_i is the corresponding number of events (G1+G2+G3+G4). Approximate 95% confidence limits are given by $\sum w_i (\sum w_i d_i/e_i) \pm 1.96 \text{ SEM}$, where $\text{SEM}^2 = \sum w_i^2 d_i (e_i - d_i)/e_i^3$.

Results

The study populations, total numbers of fatal and nonfatal events, and the numbers in each outcome

group for the period 1985 through 1989 are shown in Table 2.

The percentages of registered fatal events failing to meet the MONICA criteria were around 3% for all the study populations even though the autopsy rates varied from 7% in Augsburg to 79% in Turku/Loimaa for all deaths (Figs 1 and 2).

The average age-standardized rates for fatal and nonfatal events are shown in Fig 1 for men and in Fig 2 for women. Among men, the death rates in North Karelia, Finland, were 2.8 times higher than in Augsburg, Germany; rates for men in Australia and New Zealand were intermediate between these extremes. Rates for nonfatal AMI in men showed similar patterns as the death rates. For women, the rates for fatal and nonfatal events were highest in Newcastle, Australia, where they were more than double those in Augsburg. These differences in rates between the study populations occur in each of the five registration years.

Fig 3 shows the percentages of deaths that occurred at various stages of the acute event for men and women together (as differences in these percentages between the sexes were small). In all of the study populations, about two thirds of coronary deaths occurred before the patient reached the hospital. Of all deaths, 11% (Kuopio) to 26% (Bremen) occurred in-hospital within the first 24 hours from onset of symptoms. The remaining deaths are those that occurred between 24 hours and 28 days after onset.

Case fatality with 95% confidence intervals by the five definitions is shown in Table 3. The age-standardized 28-day case fatalities (CF1) in men and women were highest in Augsburg (50% resp. 58%), Turku (51% resp.

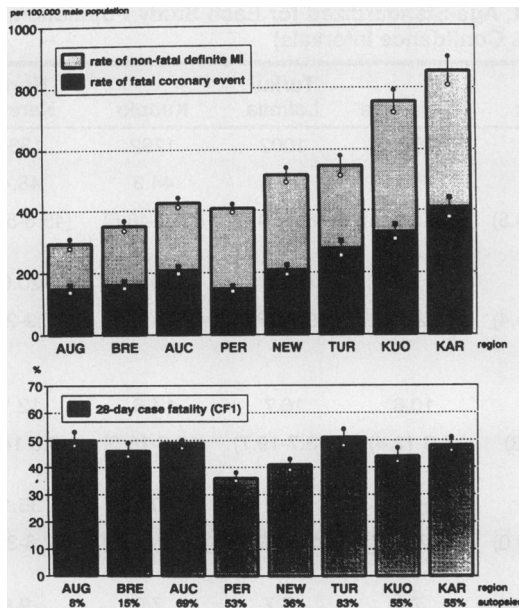


FIG 1. Bar graphs of coronary event rates and case fatality in men: Rates of nonfatal and fatal events per 100 000 population per year and 28-day case fatality in percentages (age-standardized for ages 35 to 64 years and averaged for 1985 through 1989, with 95% confidence limits) and age-standardized autopsy rates in percentages.

55%), and Auckland (49% resp. 50%). The CF1 in men was lowest in Perth (37%) and Newcastle (41%) and in women in Kuopio (38%) and Newcastle (40%). The 28-day case fatality for all hospitalized cases (CF2) was

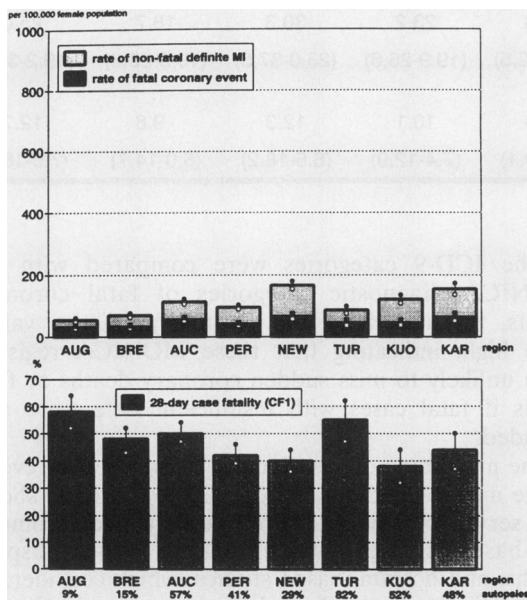


FIG 2. Bar graphs of coronary event rates and case fatality in women: Rates of nonfatal and fatal events per 100 000 population per year and 28-day case fatality in percentages (age-standardized for ages 35 to 64 years and averaged for 1985 through 1989, with 95% confidence limits) and age-standardized autopsy rates in percentages.

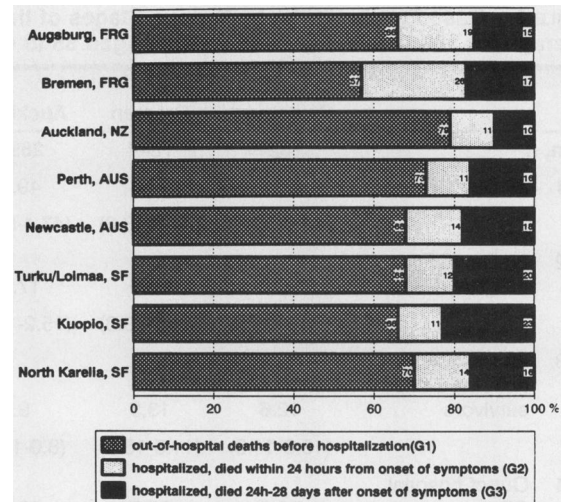


FIG 3. Bar graph of percentages of deaths at various stages: Crude percentages for men and women aged 35 to 64 years in 1985 through 1989.

highest in the German centers (Bremen: men, 27%; women, 30%; Augsburg: men, 26%; women, 31%) and for women in Turku (35%). If only the hospitalized 24-hour survivors were included, CF3, there were no significant differences in the 28-day case fatalities (men, 11% to 17%; women, 12% to 26%), with the exception of the male patients in Perth (8%) and Auckland (9%). Out-of-hospital case fatality, CF4, was highest for men in Auckland (39%), Turku/Loimaa (37%), and North Karelia (35%) and for women in Augsburg (40%). The 24-hour case fatality in hospitalized cases, CF5, showed the largest differences, with percentages in Augsburg (men, 15%; women, 20%) and Bremen (16% resp. 17%) more than double those in Perth (8%) or Kuopio (7% resp. 10%). Case fatality was generally higher for women than men in the same population.

When the calculations in Table 3 were done separately for two age groups, 35 to 54 and 55 to 64 years, case fatality was higher in the older age group. In men, the 28-day case fatality (CF1) in those aged 55 to 64 years was 1.2 to 1.5 times higher than in the 35 to 54 age group; for CF2, the range was 1.5 to 2.3; and for CF3, it was 1.7 to 2.9, indicating increasing relative risk of death later in the event among the older group. The age differences were greater in the Australasian populations than in the European ones. For women, the trend for higher risk of death later in the event in the older group compared with the younger group was also apparent in the Australasian and German populations: for CF1, the range was 1.1 to 1.3; for CF2, 1.3 to 2.0; and for CF3, 1.7 to 4.6. In all centers, these differences were smaller in women than in men.

Case fatality for hospitalized cases stratified by first or recurrent AMI is shown in Tables 4 and 5. The differences between populations were smaller than the respective figures shown in Table 3 but showed the same patterns. In particular, case fatality for recurrent events was much higher in the two German centers than in the other centers, for both men and women. For women, case fatality from first AMI among hospitalized patients was lowest in Newcastle and Perth and particularly high

TABLE 3. Case Fatality (in %) by Various Stages of the Acute Event, Age-Standardized for Each Study Population, Average for 1985-1989, Men and Women Aged 35 to 64 Years (95% Confidence Intervals)

		Augsburg	Bremen	Auckland	Perth	Newcastle	Turku/ Loimaa	Kuopio	North Karelia
Men, n		1521	1844	2893	3421	1877	1002	1782	1384
CF1	28-Day CF	50.2 (47.7-52.7)	46.3 (44.0-48.6)	49.2 (47.4-50.1)	36.9 (35.2-38.5)	41.2 (39.0-43.4)	51.1 (48.0-54.2)	44.3 (42.0-46.6)	48.4 (45.8-51.0)
CF2	28-Day CF for hospital cases	25.8 (23.2-28.5)	26.9 (24.5-29.3)	17.0 (15.2-18.7)	13.1 (11.7-14.4)	17.2 (15.2-19.2)	23.0 (19.7-26.2)	20.5 (18.3-22.7)	20.6 (17.9-23.2)
CF3	28-Day CF for hospital 24-hour survivors	12.6 (10.3-14.8)	13.5 (11.5-15.5)	9.4 (8.0-10.8)	8.2 (7.0-9.3)	10.6 (8.9-12.4)	16.7 (13.7-19.7)	14.6 (12.6-16.6)	12.1 (9.8-14.3)
CF4	Out-of hospital CF	32.9 (30.6-35.3)	26.7 (24.7-28.8)	38.9 (37.1-40.7)	27.6 (26.1-29.0)	29.2 (27.2-31.3)	36.6 (33.6-39.6)	30.1 (27.9-32.2)	35.1 (32.6-37.6)
CF5	24-Hour CF for hospital cases	15.3 (13.1-17.5)	15.7 (13.7-17.6)	8.4 (7.1-9.7)	5.3 (4.4-6.1)	7.4 (6.0-8.8)	7.7 (5.6-9.7)	7.0 (5.6-8.4)	9.8 (7.8-11.7)
Women, n		332	445	788	800	638	201	330	280
CF1	28-Day CF	58.2 (52.4-63.9)	47.5 (42.7-52.3)	50.4 (46.8-53.9)	43.6 (40.0-47.1)	39.6 (35.7-43.5)	54.5 (46.8-62.3)	38.2 (32.1-44.3)	43.6 (37.3-49.8)
CF2	28-Day CF for hospital cases	30.9 (24.2-37.5)	30.1 (25.0-35.1)	24.5 (20.9-28.2)	20.3 (16.9-23.6)	21.3 (17.7-24.9)	34.6 (25.7-43.6)	24.2 (18.1-30.2)	25.3 (18.4-32.3)
CF3	28-Day CF for hospital 24-hour survivors	14.0 (9.0-19.0)	16.0 (11.8-20.3)	16.1 (12.9-19.4)	13.4 (10.4-16.3)	12.4 (9.4-15.3)	25.5 (16.6-34.4)	15.7 (11.3-20.1)	14.4 (8.1-20.7)
CF4	Out-of hospital CF	39.6 (33.9-45.2)	25.1 (20.9-29.3)	34.1 (30.7-37.4)	29.3 (26.0-32.5)	23.2 (19.9-26.6)	30.3 (23.0-37.5)	18.7 (13.5-23.8)	25.0 (19.2-30.8)
CF5	24-Hour CF for hospital cases	19.6 (13.7-25.5)	16.7 (12.4-20.9)	10.1 (7.5-12.7)	7.9 (5.6-10.1)	10.1 (7.4-12.9)	12.3 (6.5-18.2)	9.8 (5.0-14.7)	12.7 (7.0-18.5)

CF indicates case fatality.

in Turku/Loimaa. In men, case fatality from first AMI was consistently lowest in Perth.

Discussion

The value of international comparative studies such as this depends on the extent to which the data are truly comparable. Collection of carefully defined data items, standardized diagnostic criteria, and regular quality assessment in the WHO MONICA Project are strengths of the present study. Once a coronary event is registered and diagnostic information collected, the classification in nonfatal cases is likely to be the same in all centers, provided that the proportion of missing data for the diagnostic variables symptoms, ECGs, and cardiac enzymes is small. As described in the "Methods" section, the large differences in the autopsy rates do not bias the comparability of this study.

Validation studies for ascertainment of deaths have been published from several of the centers.^{7,8,15} When death certificate diagnoses coded as 410-414 according

to the ICD-9 categories were compared with the MONICA diagnostic categories of fatal coronary events, the sensitivity and positive predictive values were high, indicating that these MONICA registers were unlikely to miss sudden coronary deaths or fatal AMIs if fatal cases with insufficient data were also included.

The magnitude of case fatality from coronary events in the middle-aged populations (35 to 64 years) shown here serves to highlight the difference between community-based studies, which include out-of-hospital deaths, and hospital-based studies, which considerably underestimate the total number of coronary deaths that occur in a population. Case fatality of 40% to 50% is typically reported from community studies of AMI.¹⁶⁻²⁰ In contrast, hospital-based studies, which include deaths in accident and emergency departments and typically use case fatality definitions similar to CF2, obtain rates of about half the size of CF1.^{13,21-24} Studies of case fatality in cases who survive several hours after

TABLE 4. Case Fatality (In %) by First and Recurrent AMI by Various Stages of the Hospitalized Acute Event, Age-Standardized for Each Study Population, Average for 1985-1989, Men Age 35 to 64 (95% Confidence Intervals)

	Augsburg	Bremen	Auckland	Perth	Newcastle	Turku/ Loimaa	Kuopio	North Karelia
First MI								
CF2 28-Day CF for hospital cases	18.9 (16.1-21.7)	17.0 (14.6-19.5)	12.7 (10.9-14.6)	8.4 (7.0-9.7)	13.7 (11.4-15.9)	18.4 (14.6-22.1)	14.4 (11.9-16.9)	15.9 (12.9-19.0)
CF3 28-Day CF for hospital 24-hour survivors	10.8 (8.5-13.2)	9.6 (7.5-11.6)	6.8 (5.3-8.2)	5.2 (4.0-6.3)	9.0 (7.1-10.9)	13.8 (10.3-17.2)	10.0 (7.8-12.3)	9.2 (6.7-11.7)
CF5 24-Hour CF for hospital cases	9.1 (7.0-11.2)	8.3 (6.5-10.2)	6.4 (5.1-7.8)	3.4 (2.5-4.2)	5.2 (3.7-6.6)	5.5 (3.3-7.7)	4.9 (3.3-6.4)	7.5 (5.3-9.7)
Recurrent MI								
CF2 28-Day CF for hospital cases	42.8 (36.5-49.2)	45.9 (40.6-51.1)	27.4 (23.5-31.2)	22.7 (19.5-25.8)	20.3 (16.2-24.4)	32.4 (26.0-38.7)	30.1 (26.0-34.2)	29.6 (24.5-34.7)
CF3 28-Day CF for hospital 24-hour survivors	19.9 (14.0-25.7)	25.9 (20.2-31.6)	16.4 (12.9-19.9)	15.5 (12.6-18.3)	13.1 (9.5-16.8)	23.2 (17.1-29.3)	22.6 (18.6-26.6)	17.2 (12.7-21.7)
CF5 24-Hour CF for hospital cases	28.7 (22.9-34.5)	27.3 (22.5-32.1)	13.2 (10.2-16.1)	8.6 (6.4-10.7)	8.4 (5.5-11.3)	12.0 (7.6-16.4)	10.0 (7.4-12.6)	15.0 (10.9-19.0)

CF indicates case fatality and MI, myocardial infarction.

reaching the hospital are substantially lower, as shown here by CF3, which applies to people who survive the first 24 hours from onset of symptoms.²⁵

For most of the definitions and subgroups, case fatality among the populations included in this analysis was generally highest in the German centers and in Turku/Loimaa in Finland and lowest in the Australian centers. This is in marked contrast to the averaged mortality and attack rates, which are lowest in Germany and highest in the two Finnish centers of North Karelia and Kuopio.

The differences were greatest for early case fatality of hospitalized cases, especially CF5. This was to be expected because these are affected most by the heterogeneous group of hospital deaths within the first 24 hours after onset of symptoms. This group includes patients admitted both early and late to the hospital who may have received a wide range of medical care. Indeed, a community in which time delays between onset of symptoms and arrival at hospital were short could expect to have higher case fatalities by these definitions because relatively more patients arrive at the hospital before death occurred. This might be the case in Bremen.

Twenty-eight-day case fatality for 24-hour survivors, CF3, is relatively unaffected by time delays and instead reflects only differences in severity of AMI and effectiveness of acute coronary care. Values for CF3 are similar for all study populations except Turku/Loimaa, which showed particularly high CF3 rates for both men and women. No definitional or logistic problems that explain the higher CF3 in Turku/Loimaa have been

identified. The strategy used to treat hospitalized patients, however, differs considerably among the centers; for example, length of hospital stay for survivors ranges from 8 days in Perth, Australia, to 27 days in Bremen, Germany.^{10,26} The similarity of CF3 values suggests that coronary care either does not differ much between centers or that variations in medical care have relatively little effect on outcome at least in the first 28 days (although there might be longer-term differences in outcome), which was also reported before.²⁷ It is equally unlikely that the differences in the rates of nonfatal AMI between the centers are due to regional differences in public awareness concerning symptoms and treatment of heart disease. Theoretically, the latter might influence the proportion of "silent" nonfatal AMI coming to medical attention, thus decreasing the CF3 figures.²⁸

As expected, case fatality at all stages was higher for recurrent events than first events. Case fatality was higher in the older age group, 55 to 64 years, than in patients aged 35 to 54 years and higher in women than in men, especially among 24-hour survivors. However, the rates of sudden coronary deaths are higher in the male population.^{29,30}

It is noticeable that the populations with the lowest CHD event rates, Augsburg and Bremen, have the highest case fatality rates. Similarly, women who have much lower CHD event rates than men have higher case fatality rates (Figs 1 and 2). Obviously, the smaller differences in case fatality among the populations studied do relatively little to account for the large differences in CHD death rates, which are also paralleled by marked differences in attack rates of AMI.

TABLE 5. Case Fatality (in %) by First and Recurrent AMI by Various Stages of the Hospitalized Acute Event, Age-Standardized for Each Study Population, Average for 1985-1989, Women Age 35 to 64 (95% Confidence Intervals)

		Augsburg	Bremen	Auckland	Perth	Newcastle	Turku/ Loimaa	Kuopio	North Karelia
First MI									
CF2	28-Day CF for hospital cases	23.2 (16.4-30.0)	22.9 (17.7-28.1)	20.8 (16.8-24.7)	15.2 (11.4-18.9)	15.5 (11.8-19.3)	35.3 (24.8-45.8)	19.0 (13.8-24.2)	17.7 (11.1-24.3)
CF3	28-Day CF for hospital 24-hour survivors	9.6 (5.3-13.9)	14.5 (10.2-18.8)	13.9 (10.4-17.3)	10.1 (6.8-13.3)	10.8 (7.6-14.0)	25.1 (14.5-35.7)	12.9 (8.3-17.6)	10.2 (4.1-16.2)
CF5	24-Hour CF for hospital cases	14.8 (8.8-20.9)	9.7 (5.8-13.5)	8.1 (5.3-10.8)	5.6 (3.2-7.9)	5.3 (2.9-7.7)	13.9 (6.2-21.5)	7.1 (3.7-10.5)	8.9 (3.5-14.3)
Recurrent MI									
CF2	28-Day CF for hospital cases	62.8 (48.6-77.0)	47.3 (33.8-60.8)	36.7 (27.9-45.5)	29.1 (22.0-36.1)	28.2 (19.1-37.3)	31.6 (17.1-46.1)	33.6 (21.2-45.9)	36.8 (25.4-48.1)
CF3	28-Day CF for hospital 24-hour survivors	44.4 (23.6-65.2)	18.9 (9.1-28.8)	24.5 (16.0-33.1)	21.0 (12.6-25.3)	12.3 (6.0-18.5)	24.5 (10.2-38.7)	22.9 (12.3-33.5)	23.2 (12.6-33.9)
CF5	24-Hour CF for hospital cases	37.2 (21.3-53.1)	34.3 (21.2-47.4)	16.2 (9.4-22.9)	12.3 (6.9-17.6)	18.0 (9.9-26.2)	9.4 (1.8-16.9)	12.9 (4.6-21.2)	16.6 (8.0-25.2)

CF indicates case fatality and MI, myocardial infarction.

Attempts to reduce case fatality, especially in the first hours after onset of symptoms, need to be viewed from the perspective provided by Fig 3, namely, that most deaths occur before reaching the hospital, which was reported similarly by the Minnesota Heart Survey since 1950.^{17,31} The American Heart Association's concept of the "chain of survival" is helpful in this context.³² It emphasizes the need to react faster, not only on the part of the medical system but also on the part of the patient. However, the proportion of lives that might be saved if such systems operated at maximal effectiveness is unknown.

For clinicians, the differences in case fatality in hospitalized patients raise many questions. To address these, information is needed on the severity of cases and on medical care of patients (including drugs, investigations, and procedures) before, during, and after an acute event. In the WHO MONICA Project, data on these aspects are being collected so that much more detailed elucidation of the differences reported here will be possible later.

However, the differences in event rates compared with those in case fatality point to the greater importance of primary and secondary prevention than medical care in the AMI if mortality from CHD is to be reduced.³³ This is exemplified by the fact that in all centers, about two thirds of those who died within 28 days died before they reached the hospital (see Fig 3).

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