Deaths from ischaemic heart disease in Belfast

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SUMMARY There were 1323 deaths due to ischaemic heart disease in Belfast from 20 July 1981 to 19 July 1982. Some 496 (37%) of these were in persons aged <70 years. By World Health Organisation criteria 247 (19%) of these deaths were classified as definite myocardial infarction and 749 (57%) as possible myocardial infarction. Dyspnoea, collapse, and typical pain were the main symptoms at the onset of the fatal attack. In hospital only 12% of deaths in persons aged <70 years and 14% of those aged ≥70 years were due to presumed primary rhythm disturbance, whereas outside hospital these proportions were 78% and 59% respectively. The median survival time was 84 minutes and was shortest in men aged <70 years (62 minutes). Outside hospital a relative was the most likely aid sought initially (70%) and the median delay time from onset of symptoms to calling for medical aid was eight minutes. Among 128 witnessed deaths in persons aged <70 years occurring outside hospital due to presumed primary rhythm disturbance the median survival time was 8.25 minutes.

Improvements in facilities available for resuscitation including public education could result in the prevention of a proportion of deaths caused by primary rhythm disturbances.

The largest single cause of mortality in developed countries today is ischaemic heart disease. Many of these deaths occur very rapidly after the onset of a coronary attack and are due to ventricular fibrillation.

We studied the circumstances of deaths from ischaemic heart disease by examining all deaths in residents of Belfast during a one year period. We investigated the various delays involved in initiating medical care in Belfast, which has two mobile coronary care units. Deaths in persons aged <70 years and in persons aged ≥70 years are described separately. Comparison with a study of deaths from ischaemic heart disease in Belfast in 1965-66 reported by McNeilly and Pemberton¹ will be described elsewhere.

Patients and methods

POPULATION STUDIED

Two Belfast hospitals, the Royal Victoria Hospital

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Accepted for publication 13 January 1986

and the Ulster Hospital, Dundonald, provide mobile coronary care units. Access to the ordinary emergency ambulance by the general public is by means of a 999 telephone call. If the ambulance controller suspects a heart attack the call is transferred to a mobile coronary care unit. The mobile coronary care unit also accepts calls from general practitioners and former patients to a special emergency telephone number. There are about 200 general practitioners, and some 30 practices use a deputising service at night and at weekends.

The population studied (355 980) included all men and women of all ages resident in the city of Belfast and the adjacent local government district of Castlereagh. This area is conterminous with the boundaries of three health and social services districts (North and West Belfast, South Belfast, and East Belfast and Castlereagh). We investigated all deaths occurring in residents of the study area during one year from 20 July 1981 to 19 July 1982 inclusive.

ASCERTAINMENT OF DEATHS

Several procedures were used before a death was accepted as being due to ischaemic heart disease. The first and primary source of ascertainment was the death certificates filed at the General Register Office for Northern Ireland. All deaths attributed to Inter-

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national Classification of Diseases 410-414 (Ninth Revision 1975) were presumed to be due to ischaemic heart disease. We also scrutinised all certificates relating to Belfast residents dying from any cause. Deaths that were thought probably or possibly to have been due to ischaemic heart disease were provisionally included. Then these presumed ischaemic heart disease deaths were verified by other sources including records from hospitals, necropsy reports, the Coroner's Office, general practitioners, and ambulance services. In 302 instances necropsy reports were available. Thirdly, 775 home visits were made by a study doctor or social worker to the relatives of the deceased or an informant between three and eight weeks after the death. These interviews took place in order to clarify the circumstances relating to fatalities outside hospital in particular and to other items. Eye witnesses of fatal attacks that began in the street and elsewhere also were interviewed. A panel of cardiologists from the Regional Medical Cardiology Centre, Royal Victoria Hospital, assessed data relating to equivocal cases. The diagnostic criteria that were used for acute myocardial infarction were based on those set out by the World Health Organisation in 1981² but without the Minnesota coding of electrocardiographs. Survival times were measured from the onset of symptoms to the time of death. In accord with the World Health Organisation protocol onset was defined as the start of severe acute symptoms, excluding prodromal symptoms, with a maximum survival time of 28 days. Survival times were known within $\pm 5\%$ for 715 deaths. Deaths from sudden collapse without

previous symptoms were assigned a survival time of four minutes unless cardiopulmonary resuscitation was carried out. The survival time could not be estimated to within $\pm 5\%$ in 145 deaths, 265 deaths were unwitnessed, and in 152 the fatal attack had no specific onset.

We used the χ^2 test for statistical analysis. Permission for the study was given by the medical ethical committee, and visits to relatives were made only with consent from the deceased person's general practitioner. One family practice refused to participate, and seven relatives refused interview.

Results

Scrutiny of death certificates produced 1654 deaths which were possibly due to ischaemic heart disease. Assessment of clinical and other data relating to all deaths coded as 410-414 and the possible deaths coded by other International Classification of Diseases numbers excluded 331, leaving 1323 deaths for further investigation.

DIAGNOSIS BY WORLD HEALTH ORGANISATION CRITERIA

Some 56% of all deaths from ischaemic heart disease occurred in men aged between 35 and 95 years (mean 69 years). The other 44% were in women aged between 41 and 99 years (mean 76 years); 48% of the male deaths and 25% of the female deaths were in people aged <70 years (Table 1). In those aged <70 assessment by World Health Organisation criteria showed that 128 deaths (26%) were

Table 1 *Mortality from ischaemic heart disease over one year (1981-82) in Belfast*

Age group	Population		Numbers of deaths		Mortality rates/1000	
	Male	Female	Male	Female	Male	Female
< 70 yr	156 621	165 026	351	145	2.2	0.9
≥ 70 yr	11 502	22 831	384	443	33	19
All ages	168 123	187 857	735	588	4.4	3.1

Table 2 *Main symptom at the onset of the fatal attack by age and sex*

Symptom	Males		Females	
	< 70 yr	≥ 70 yr	< 70 yr	≥ 70 yr
Dyspnoea	35 (13)	90 (30)	31 (27)	123 (36)
Collapse	93 (34)	83 (28)	24 (21)	64 (18)
Typical pain*	88 (32)	72 (24)	40 (35)	63 (18)
Atypical pain†	23 (8)	19 (6)	6 (5)	21 (6)
Other	36 (13)	37 (12)	13 (12)	75 (22)
Total	275 (100)	301 (100)	114 (100)	346 (100)

Numbers in parentheses are percentages.

*Including chest, arm, and neck pain but excluding mild pain in any site.

†Including epigastric and back pain and mild chest, arm, and neck pain.

classified as definite myocardial infarction, 306 (62%) as possible myocardial infarction, and in 62 (12%) there was insufficient evidence for classification. In those aged 70 years and above the numbers were 119 (14%), 443 (54%), and 265 (32%) respectively.

MAIN SYMPTOM AT ONSET

We ascertained the main symptom at the onset of the fatal attack in relation to 1036 deaths. We excluded 287 deaths (107 in persons aged <70 years). The reason for most exclusions was because the fatal attack was unwitnessed. For the 275 men aged <70 years sudden collapse without prior warning was the most common main symptom and occurred in 93 (34%) (Table 2). Typical cardiac pain was almost as common (88 cases (32%)). The distribution of symptoms in females aged <70 years was significantly different from that in men aged <70 years ($\chi^2 = 15.76$, $p < 0.01$). The most common symptom was typical pain (40 (35%) of 114), with dyspnoea in 31 (27%) and collapse in 24 (21%). The distribution of symptoms in men aged ≥ 70 years was significantly different from that in younger men

($\chi^2 = 25.64$, $p < 0.001$). Dyspnoea was the most common main symptom (90 (30%) of 301 persons), with collapse in 83 (28%) and typical pain in 72 (24%). Dyspnoea was the most common symptom in females aged ≥ 70 years, occurring in 123 (36%) of 346. Other non-specific symptoms were common (75 cases (22%)). This distribution was significantly different from that in women aged <70 years ($\chi^2 = 17.81$, $p < 0.01$) and from that in men aged ≥ 70 years ($\chi^2 = 18.12$, $p < 0.01$).

MODE OF DYING

Deaths from ischaemic heart disease were due mainly to pump failure or a presumed primary rhythm disturbance, of which the most frequent is known to be ventricular fibrillation (Table 3). People who collapsed suddenly were judged to have died from a primary rhythm disturbance as were those who were found dead (often in bed), unless there was some evidence of distress before death. Thirteen cases were found to have ventricular rupture at necropsy and we have included these in the "other" category. Also included in this category are those who collapsed in cardiac arrest without pre-

Table 3 *Mode of dying inside and outside hospital by age*

Mode of dying	Inside hospital		Outside hospital	
	< 70 yr	≥ 70 yr	< 70 yr	≥ 70 yr
Heart failure and shock	139 (76)	261 (71)	34 (12)	110 (26)
Presumed primary rhythm disturbance	21 (12)	53 (14)	229 (78)	259 (59)
Other	20* (11)	37† (11)	11 (4)	6 (1)
Unknown	1 (1)	14 (4)	18 (6)	64 (14)
Total	181 (100)	365 (100)	292 (100)	439 (100)

Numbers in parentheses are percentages.

*Including 1 death due to pulmonary embolism and 5 due to arterial embolism.

†Including 3 deaths due to pulmonary embolism and 6 due to arterial embolism.

Table 4 *Survival times by age and sex*

Time	Males		Females		Both sexes
	< 70 yr	≥ 70 yr	< 70 yr	≥ 70 yr	
0-4 min	34 (16)	52 (24)	12 (14)	42 (20)	140 (19)
5-14 min	29 (15)	23 (11)	14 (16)	23 (11)	89 (13)
15-29 min	12 (6)	13 (6)	6 (7)	13 (6)	44 (6)
30-59 min	27 (13)	12 (6)	9 (10)	14 (7)	62 (9)
Total < 1 hr	102 (50)	100 (47)	41 (47)	92 (44)	335 (47)
1-6 hr	35 (17)	21 (11)	8 (9)	14 (6)	78 (11)
6-24 hr	11 (5)	27 (12)	12 (14)	25 (12)	75 (10)
1-7 days	34 (16)	38 (18)	12 (14)	43 (21)	127 (18)
7-28 days	24 (12)	27 (12)	14 (16)	35 (17)	100 (14)
Total	206 (100)	213 (100)	87 (100)	209 (100)	715 (100)
Not known accurately*	126 (38)	159 (43)	54 (38)	223 (52)	562 (44)
Total	332 (100)	372 (100)	141 (100)	432 (100)	1277 (100)
Median times (min)	62	90	90	340	84

Numbers in parentheses are percentages.

*Includes 265 unwitnessed, 152 with no specific onset of the attack, and 145 deaths known with accuracy greater than $\pm 5\%$.

vious pump failure in whom a satisfactory electrocardiogram rhythm was continuously present or was established by immediate efficient resuscitation, but without any concomitant cardiac output. Data relating to the mode of dying were obtained for the 1277 deaths whose fatal attack occurred within the study area. A total of 546 occurred inside hospital and 731 outside hospital. Only 74 deaths (13.5%) were due to presumed primary rhythm disturbance and 400 (73%) were due to pump failure in the inside hospital group. The distribution was reversed in persons dying outside hospital where 488 deaths (67%) were judged to be due to presumed primary rhythm disturbance and 144 (20%) to pump failure ($\chi^2 = 476.54$, $p < 0.001$). This difference in the mode of dying was significant in those aged <70 years ($\chi^2 = 241.88$, $p < 0.001$) and in those aged ≥ 70 years ($\chi^2 = 247.15$, $p < 0.001$).

SURVIVAL TIME

Seven per cent (34 of 473) of those aged <70 years and 15% (118 of 804) of those aged ≥ 70 had no specific onset of symptoms. In a further 410 cases (146 aged <70 years) the survival time was not known with sufficient accuracy (that is $\pm 5\%$) and these were excluded from the analysis of survival times (Table 4). Some 140 persons (19%) survived for up to four minutes only. For all persons the median survival time from the onset of symptoms to death was 84 minutes. It was nearly twice as long (121 minutes) in those ≥ 70 compared with those <70 years of age (65 minutes). χ^2 analysis of the time intervals showed that the distribution of survival times was not significantly different in men and women in both age groups or in women aged <70 years and those aged ≥ 70 years, but it was

significantly different in men aged <70 years and those aged ≥ 70 years ($\chi^2 = 20.79$, $p < 0.01$).

AID REQUESTED AND ASSOCIATED DELAYS
Most attacks began at home—335 (71%) in those aged <70 years and 538 (67%) in those aged ≥ 70 years among the 1277 deaths occurring inside the study area.

For the age group <70 years the attack began in the street in 36 (8%), at work in 23 (5%), at a place of public entertainment in 11 (2%), in hospital for non-cardiac reasons in 57 (12%), or in other places in 11 (2%). For the age group ≥ 70 years the onset was in the street for 32 (4%), at work in one, in places of public entertainment in three, in general practitioners' surgeries in two; a large number (215 (16%)) were already in hospital, mainly in geriatric wards; and 69 (9%) were in nursing homes or old people's homes. The distribution of deaths by place of onset is not quite the same as the distribution of deaths by place of death. Some 230 (79%) of the 292 deaths outside hospital that occurred in persons aged <70 years and 361 (82%) of the 439 deaths in persons aged ≥ 70 years took place at home. Considering all ages there were 42 deaths in the street, 18 at work, 18 in places of public entertainment, four in general practitioners' surgeries, and 55 in nursing and old people's homes. The respective figures for the age group <70 years are 20, 17, nine, one, and six deaths. There were 13 deaths during transit to hospital, nine occurring in persons aged <70 years.

Some form of aid was sought by 809 (77%) persons out of the 1062 persons with onset of attack outside hospital and within the study area. In 564 (70%) cases a relative was summoned first, a lay person in 124 (15%), and another person, usually a

Table 5 Median delay times for requesting medical care

Delay time	< 70 yr		≥ 70 yr	
	No of persons	Time (min)	No of persons	Time (min)
Onset of fatal attack to call for first (lay) aid	253	1.1	306	1.1
Call for first aid to call for medical aid	258	5	283	5
Onset to call for medical aid	228	10	229	8
Onset to call for MCCU	107	15	62	15
Onset to call for OA	120	7	132	21
Call for GP to arrival of GP	70	15	157	30
Call for DD to arrival of DD	24	21	54	20
Call for MCCU to arrival of MCCU	116	10	73	10
Call for OA to arrival of OA	144	8	211	11
Onset of fatal attack to arrival of MCCU or hospital ward/CCU care	105	90	102	195

MCCU, mobile coronary care unit; GP, general practitioner; OA, ordinary ambulance; DD, deputising doctor; CCU, coronary care unit. Persons already in hospital at onset of fatal attack are excluded. Data presented for delay times known with accuracy of $\pm 5\%$.

neighbour or staff at a nursing or old people's home in 97 (12%). The remaining 24 (3%) sought medical aid themselves. Medical aid was sought for 297 (72%) of those aged <70 years. The aid requested was the ordinary ambulance for 87 (29%), the general practitioner for 86 (29%), the mobile coronary care unit for 77 (26%), the deputising doctor for 27 (9%); nine (3%) came direct to hospital accident and emergency departments, and 11 (4%) sought other forms of medical aid. For persons aged ≥70 years 214 (51%) requested their general practitioner, 82 (20%) the ordinary ambulance, 64 (15%) a deputising doctor, 48 (11%) the mobile coronary care unit, five came direct to hospital accident and emergency departments, and four sought other medical aid.

Table 5 summarises the median delay times where they were known within an accuracy of ±5%. Both the median delay time in calling for first (lay) aid (1 minute) and the delay in calling for medical aid (10 minutes in those aged <70 years and eight minutes in those aged ≥70 years) are very short. The median delay times for the arrival of medical aid are also very short, varying from eight minutes for the ordinary ambulance in the case of younger people to 30 minutes for the general practitioner in the case of older people.

WITNESSED DEATHS DUE TO PRESUMED PRIMARY RHYTHM DISTURBANCE OUTSIDE HOSPITAL

We identified a subgroup of 128 deaths that occurred outside hospital in those aged <70 years

Figure Ascertainment of the number of potentially preventable deaths.

where death was witnessed by a person aged 13-64 years and was due to presumed primary rhythm disturbance (Figure). There were 97 males (76%) and 31 females. Some 18 (14%) had definite myocardial infarction, 92 (72%) had possible myocardial infarction, and 18 (14%) had insufficient evidence to make a classification. Only 61 (49%) had known previous ischaemic heart disease, 14 (11%) had possible previous ischaemic heart disease (not diagnosed) or very recent angina, and 53 (41%) had no previous history. The majority (80 (62%)) presented with sudden collapse and the median survival time was 8-25 minutes. A mobile coronary care unit attended 54 persons (42%) either as the first medical aid (40) or as back up to other services (14). Cardiopulmonary resuscitation had been initiated by bystanders in 55 cases (43%) but was apparently efficient in nine cases only. The majority (73 (57%)) had no cardiopulmonary resuscitation carried out before the arrival of medical aid although nearly all cases had already collapsed (115 (96%)) of 120 cases where medical aid was sought).

Discussion

The present study of deaths in Belfast illustrates the difficulties of providing appropriate medical care because of the circumstances surrounding fatal attacks of ischaemic heart disease. The median survival time was only 84 minutes and was shorter (65 minutes) in persons aged <70 years. The great majority (83%) of fatal attacks began outside hospital and of these 82% began in the person's home. A relative was therefore the most likely (70%) first source of aid. Although 67% of deaths outside hospital were due to a presumed primary rhythm disturbance, and were potentially treatable, many persons had no symptoms before collapse or death to alert their relatives. The classic symptom of severe crushing central chest pain radiating to the arms or neck occurred only in 33% of persons aged <70 years and 21% of those aged ≥70 years. Sudden collapse without warning was the most common (34%) presenting symptom in men aged <70 years. Once relatives or witnesses were alerted to the person's attack, the delay in calling for medical aid was very short, a median time of five minutes, and the delay times in medical aid arriving were also very short (median times ranging from eight minutes to 30 minutes).

We identified a subgroup of 128 deaths occurring outside hospital in persons aged <70 years in which death was witnessed and was due to a presumed primary rhythm disturbance. They represent 26% of all deaths in this age group. Sudden collapse was the most common presentation (62%). Wennerblom reported that 52% of witnessed deaths due to is-

chaemic heart disease occurring outside hospital in persons aged <75 years in Gothenburg presented with cardiac arrest.³ Some 53% of men and 49% of women aged <65 years whose death was witnessed outside hospital in Helsinki presented with cardiac arrest.⁴ Liberthson *et al*, reporting on sudden cardiac deaths outside hospital, stated that 50% died instantly and a further 25% died within 30 minutes.⁵ The median survival time among the 128 deaths we identified was only 8.25 minutes and 70% died within 30 minutes. It is unlikely that any system of medical care which does not provide resuscitation services outside hospital can reduce mortality in this group which includes many preventable deaths.

During the study period eight persons aged <70 years were successfully resuscitated from out of hospital cardiac arrest present before a mobile coronary care unit had arrived and they survived for at least one year. Possible strategies for dealing more effectively with this problem include training the adult population in the technique of cardiopulmonary resuscitation to enable some of those developing ventricular fibrillation at the onset of their attack to survive until the arrival of a medical team with a defibrillator. Since, however, it is common experience in the hospital coronary care unit that extremely rapid defibrillation improves survival, the provision of suitable defibrillators to selected members of the public, for example to relatives of persons known to be at risk, should be considered. In our subgroup about half of these persons could have

been identified because they had known ischaemic heart disease. Since a substantial number of persons are attended by general practitioners, deputising doctors, and ordinary ambulance staff, these groups should be equipped with defibrillators and trained in their use.

We thank the Registrar General for Northern Ireland, staff of the General Register Office, the Coroner's Office for Belfast, and many colleagues for their assistance with this study. Dr W McIlwaine was the holder of a Royal Victoria Hospital Research Fellowship and the work was supported by the Heart Trust Fund.

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