PRACTICE REVIEWED

Management of myocardial infarction: implications for current policy derived from the Nottingham Heart Attack Register

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Abstract

***Objective*—A register of patients with heart attacks in the Nottingham Health District has been maintained since 1973. Data from 1982 to 1984 inclusive, a period before trials of thrombolytic therapy started in Nottingham, were analysed to provide background information for the introduction of a policy of routine thrombolysis for appropriate patients.**

***Design*—Data were collected prospectively on all patients transported to hospital in the Nottingham Health District with suspected myocardial infarction in the years 1982–84 and on patients treated at home during that time.**

***Setting*—Two district general hospitals responsible for all emergency admissions in the health district.**

***Patients*—6712 patients admitted to hospital with suspected myocardial infarction and 1887 patients found dead on arrival at hospital. Approximately 1500 patients in whom a myocardial infarction was suspected were treated at home, but only 125 were identified who had a definite or probable infarction.**

***Results*—Among the patients admitted within 24 hours of the onset of symptoms, the median delay from onset to hospital admission was 174 minutes; 25% of patients were admitted within 91 minutes. The only factor that seemed to affect the time taken was the patient's decision to call a general practitioner or an emergency ambulance. If a general practitioner referred the patient to hospital the median delay was 247 minutes, compared with 100 minutes when the patient summoned an ambulance. Ninety three per cent of all patients were transported by ambulance. The median time from the call for the ambulance to hospital arrival was 29 minutes. Once a patient was admitted to hospital, the time to admission and general practitioner involvement seemed relatively unimportant as predictors of outcome. Patients admitted more than nine hours after onset of symptoms with a diagnosis of definite or probable infarction had a poorer outcome than those admitted earlier (in-hospital mortality 22·4% *v* 13·1%). The fatality rates of those admitted to a coronary care unit or to an ordinary medical ward are similar.**

***Conclusion*—Although the introduction of thrombolytic therapy has brought with it an increased awareness of the need to minimise any delay in time to admission, it seems that in a predominantly urban area like Nottingham, patients with a suspected heart attack will continue to be admitted to hospital most quickly if an ambulance crew rather than a general practitioner is called. Because the ambulance crew was in contact with such patients for only a short time it seems unlikely that administration of a thrombolytic drug in the ambulance would be helpful.**

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Disease registers have many functions. They can be used simply to describe disease prevalence and natural history, though clearly they can only record patients who die or who present to one of the medical services. They can be used to record patients with conditions such as diabetes or thyroid disease and timely medical assessment can prevent complications. Registers can also be particularly valuable for monitoring trends in the behaviour of patients with the disease and in providing the background information necessary for the rational introduction of new forms of treatment.

The early registers of patients with ischaemic heart disease[1 2] established the pattern of early death after the onset of symptoms in patients with heart attacks, and these observations paved the way for special ambulance facilities. The international registers supported by the World Health Organisation,[3] aimed mainly to give descriptive information to help plan provision of services for what was then seen as an "epidemic" of ischaemic heart disease. The Nottingham Heart Attack Register was set up in a simple form in 1973 and in a more definitive way in 1982 to monitor the introduction of new forms of ambulance service for patients with heart attacks, and at the same time to provide longitudinal information that might help to explain the changes in national mortality

from ischaemic heart disease that were then expected.

The acceptance of the value of thrombolysis in patients with myocardial infarction,[4 5] and the recommendation that therapy is started as soon as possible after onset of symptoms has led to a need for a detailed description of the events that determine the way such patients are managed. The Nottingham register includes details of patient actions after the onset of symptoms and records the response of the medical services to requests for assistance. These data suggest guidelines for patient management which should enable appropriate patients to be given thrombolytic treatment as quickly as possible. We describe here an analysis of data collected during 1982–84 inclusive, when the value of defibrillation in cardiac arrest was established but that of thrombolysis was not.

Methods

Throughout 1982–84 the register was maintained by a non-medical graduate (Higher Clerical Officer Grade) supported by two clerical officers. Patient case records were reviewed by a physician (JMR) for diagnostic coding. Data were stored and analysed initially on the Nottingham University main computer. Subsequent analysis was carried out by the British Heart Foundation Cardiovascular Statistics Group.

EVENTS

The register documents events suggestive of myocardial infarction which occur in or near the Nottingham Health District (population approximately 600 000). Events are identified in several ways.

(i) Hospital admissions

Nottingham is served by two hospitals, University Hospital and City Hospital, but only University Hospital has an accident and emergency department. All patients transported by ambulance as a result of a patient-initiated emergency (999) call are taken there. Patients sent in as a result of general practitioner calls may be admitted to either hospital, depending on the emergency take-in rota. Those patients with an illness that might possibly have been a myocardial infarction are identified in the records of both the accident and emergency department at University Hospital and from the admissions records of the medical wards at both hospitals. In addition, the records of the Nottingham Ambulance Service, which has a single control centre, are inspected daily. This source is valuable in identifying appropriate cases for the register. All patients with a convincing clinical history are followed until death or hospital discharge.

(ii) Coroner's records

Coroner's records are reviewed for all patients found dead on arrival at hospital.

(iii) Patients treated at home

Between 1982 and 1984 a special district nurse service was offered to all general practitioners in the Nottingham Health District. Any general practitioner who wished to treat a patient with a suspected myocardial infarction at home was invited to request three visits on successive days from a district nurse who would record an electrocardiogram and take blood for the estimation of cardiac enzymes. The electrocardiograms were taken to University Hospital and reported immediately (JMR).

To obtain information on patients kept at home, but for whom the district nurse service was not used, the records of the biochemistry laboratories of the two Nottingham hospitals were monitored for general practitioner requests for the estimation of cardiac enzymes. In addition, domiciliary visit claim forms submitted by consultants who had been asked to record an electrocardiogram in a patient's home were collected for the single year 1984.

SCOPE OF ANALYSIS

Much of the data which define the time sequence of events from onset of symptoms to hospital admission—time of onset of symptoms, to whom first call for help was made, time to arrival of general practitioner, etc—was obtained via a patient inverview conducted shortly after admission. Most patients were interviewed, but administrative constraints or the patient's condition sometimes made an interview impossible. Those patients who were interviewed were effectively selected at random, with the obvious exception that patients who died soon after admission were more likely to be missed.

Timing data were much less complete for those cases who were certified dead on arrival or who died in the accident and emergency department. Here the most comprehensive data were obtained when the event involved a sudden collapse that was witnessed and provoked an immediate request for the emergency services. Such patients reach hospital soon after the onset of symptoms. However, they are not currently candidates for thrombolysis and their inclusion in an analysis of times to admission would lead to an inappropriate bias towards shorter time intervals. Our analysis, therefore, is restricted to those patients who were alive on arrival at hospital and who were admitted to a ward or coronary care unit.

Approximately 20% of all admissions in the register arrived at hospital more than 24 hours after onset of symptoms with many of these patients reporting an interval of three days or more. Most of these admissions were the result of complications evolving after the initial symptoms. Most of these patients contacted their general practitioner at some point before admission. However, the time at which the general practitioner became involved is more often given as a date, and precise times in this group are rare. These cases are included in the overall analysis which investigates patient decision-making and hospital outcome, but they are not included in the analysis of response times.

Although the 24 hour cut off is somewhat arbitrary, it is argued that we obtain a fairer picture of the relative contributions of patient

picture of the relative contributions of patient action, general practitioner involvement, and the ambulance service to the overall time to admission in that group of patients who are believed to have the greatest potential to benefit from thrombolysis.

DEFINITIONS

Patients were assigned to diagnostic categories as follows:

"Definite" infarction—A convincing clinical history plus changes in the electrocardiogram diagnostic of recent infarction and raised concentrations of serum aspartate aminotransferase and serum hydroxybutyrate dehydrogenase to more than twice the upper limit of normal.

"Probable" infarction—A convincing clinical history plus either changes in the electrocardiogram suggestive of recent infarction or changes in the electrocardiogram not typical of recent infarction but associated with enzyme concentrations raised to more than twice the upper limit of normal.

"Possible" infarction—A convincing history plus either abnormalities in the electrocardiogram not typical of recent infarction or enzyme concentrations above the upper limit of normal.

Ischaemic heart disease—A convincing history plus electrocardiographic evidence of old infarction only.

The term "suspected infarction, not proven" was used to describe patients who were admitted because a myocardial infarction was suspected but examination showed a normal electrocardiogram and normal enzyme concentrations.

STATISTICAL ANALYSIS

Times between key events, onset of symptoms, call for general practitioner etc, were recorded in the database in two ways. Where possible, precise time intervals were calculated, but often the information was volunteered in the form of an estimate, for example, "a delay of between two and four hours". Medians and other quantiles were therefore calculated by linear interpolation on grouped data, Armitrage and Berry.[6] Because samples were large, there was very little loss of precision with this approach. All statistical tests comparing time distributions were carried out on similarly grouped data, using "location shift" models within the class of generalised logistic regression models described by McCullagh.[7]

Results

PATIENTS ADMITTED TO HOSPITAL

The register documents 8599 events during the 1982–84 period where a suspected myocardial infarction led to a request for hospital services. In 1887 cases, the patients were either certified dead on arrival or died in the accident and emergency department. Of these, 1497 (79·3%) were certified as having died of coronary heart disease. The other 6712 events resulted in admission to a ward or coronary care unit. Five thousand, eight hundred and seventy four (87·5%) of these events affected patients who lived within the district health authority boundary. Most of the remainder represented cross boundary flow from adjacent authorities.

TIME BETWEEN ONSET OF SYMPTOMS AND HOSPITAL ADMISSION

The time of both onset of symptoms and arrival in hospital is known for 4526 (67·4%) of the 6712 patients who survived to admission. In a further 1814 (27%), the interval between onset of symptoms and hospital arrival was given as a range—eg, 6–12 hours. Times to admission ranged from a few minutes to several days. Some 1350 patients were admitted more than 24 hours after onset of symptoms, this includes 903 admitted after an interval of more than 72 hours.

For those who were admitted within 24 hours the median time from the onset of symptoms to arrival in hospital was 174 minutes. Twenty five per cent arrived within 91 minutes and 75% by 353 minutes with 90% of these admissions presenting within 11·7 hours (fig 1). Time to admission was shorter for men than women (medians 167 and 202 minutes, $p < 0{\cdot}00001$), but was longer for patients eventually shown to have a definite or probable infarction compared with other diagnostic categories (medians 179 and 172 minutes, $p < 0{\cdot}05$). Patients aged 65 or less were admitted a little quicker than those aged over 65 years (medians 169 and 183 minutes, $p < 0{\cdot}05$). The differences between median times are small compared with the spread of values in each group.

GENERAL PRACITIONER INVOLVEMENT

The most striking finding from the analysis of admission times was a considerable difference in time to admission between the group who called a general practitioner or deputising service and who were subsequently referred to hospital by this means (group A); and the group who did not call a general practitioner and whose admission was arranged by some other person (self, relative, work-mate, etc), usually by dialling 999 for an emergency ambulance (group B). In 5945 cases it was known whether an attempt had been made to contact a general practitioner. Four thousand and eighty four patients were known to have made some attempt and in 3841 of these cases the general

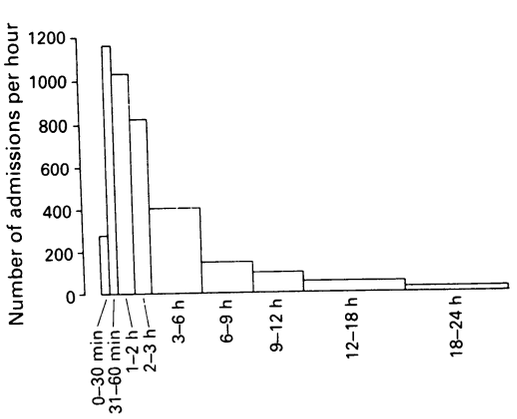

Figure 1 Distribution of time between the onset of symptoms and hospital admission in the patients admitted within 24 hours.

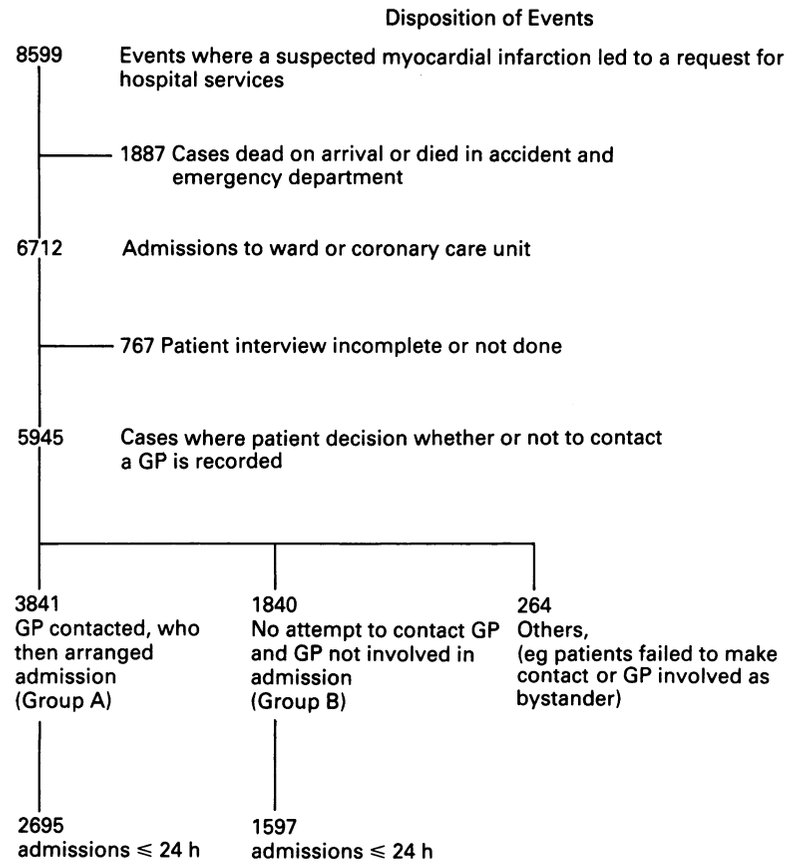

Figure 2 Data available for analysis of patients' decision whether or not to contact a general practitioner.

practitioner then arranged the admission (group A). The difference represents patients who either failed to make contact or who then arranged their own admission. It is known that in 1861 events the patients did not attempt to contact a general practitioner and that 1840 of these were admitted to hospital without any subsequent general practitioner involvement (group B), the difference is due to those events where a general practitioner was involved as a bystander (fig 2).

Two thousand, six hundred and ninety five (70%) of all group A admissions occurred within 24 hours compared with 1597 (87%) of the group B admissions. For those admitted within 24 hours, the median delay was 247 minutes in group A, but only 100 minutes in group B ($p < 0{\cdot}0001$). The decision by the patient, his relatives, or bystanders to call a general practitioner or an emergency ambulance greatly influenced the delay before hospital admission.

Figure 3 Classification of admissions by age and involvement of a general practitioner, the doctors' deputising service, or other means of hospital admission (usually by direct call for an emergency ambulance).

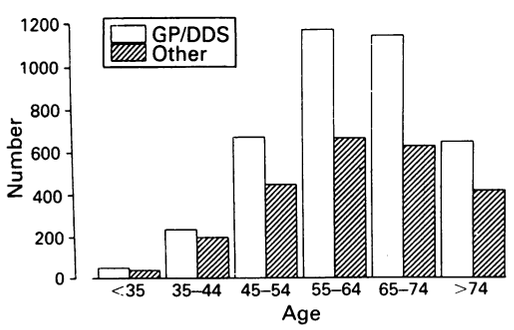

Figure 3 shows admissions by age decades and route of referral. A general practitioner was more likely to be involved if the patient was in the 55–75 year age range. However, it is not possible to determine directly whether this is because older patients were more likely to call a general practitioner or because general practitioners are effective in identifying patients in the younger age range who do not require hospital admission.

Among patients admitted within 24 hours, the delay in hospital admission associated with the involvement of the general practitioner seems to be due, in part, to the patient's action. Direct calls for an ambulance by a patient were made sooner after the onset of symptoms than calls for help to a general practitioner. The median interval from onset of symptoms to a call for an ambulance was estimated to be 74 minutes for those patients in group B admitted within 24 hours. The corresponding estimate calculated from group A patients admitted within 24 hours for the interval from onset of symptoms to calling a general practitioner is 106 minutes. However, for these same patients the estimated median interval from the onset of symptoms to the eventual call for an ambulance was 206 minutes, the difference reflecting the time taken for the general practitioner to visit the patient and decide on a course of action.

ROLE OF THE AMBULANCE SERVICE

The mode of transport to hospital was recorded in 6056 (90%) of the 6712 admissions. Most of these (5586 (92%)) patients were carried by ambulance. Similar proportions of patients eventually shown to have had a definite or probable infarction or other diagnoses were carried by ambulance (93% and 92% respectively). Transport other than by ambulance was more likely to be used when symptoms began away from home: 17% of such patients did not call for an ambulance, but when the symptoms began at home only 6% of patients used other transport.

Details of the times taken for the ambulance to reach patients and transport them to hospital were known in 4988 patients (89% of those carried by ambulance). The median time taken by the ambulance to reach the patient after receipt of the call was seven minutes. The interquartile range for these data was 5–11 minutes—ie, 50% of all times lay within this interval. The median time to arrival was essentially the same for men and women, for those aged 65 or less and those aged over 65, and for those eventually found to have had a definite or probable myocardial infarction and those in other diagnostic categories. It is not possible to determine the effect of the general practitioner on the time to arrival of an ambulance because general practitioners can summon an ambulance either by using a 999 call or by placing a routine request, but timing data are not complete in many of the cases of a routine request.

The median interval from the call for an ambulance to the arrival of the patient in hospital was 29 minutes (interquartile range 23–39 minutes). Therefore, the ambulance

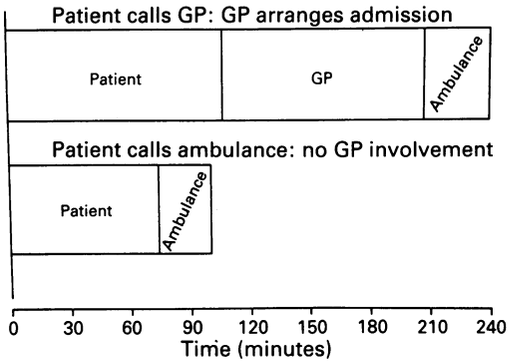

Figure 4 Median delays attributable to patient, general practitioner, and ambulance.

crew was actually in contact with the patient for about 22 minutes. Part of that time was taken loading the patient into the ambulance and part by the journey to hospital.

The median times from the call for the ambulance to arrival of the patient in hospital were within one minute for men and women, for those aged 65 or less or 65 and over, and for those eventually shown to have had a definite or probable infarction and those in other diagnostic categories. There was, however, a significant difference between the groups of patients who did or did not involve a general practitioner. The median interval from the call to the ambulance to hospital admission was 32 minutes (interquartile range 25–43 minutes) when the patient called a general practitioner and 26 minutes (interquartile range 21–31 minutes) when he did not ($p < 0{\cdot}0001$). Figure 4 summarises the various components of the overall delay between onset of symptoms and hospital admission and emphasises the additional delay that results from general practitioner involvement.

FACTORS AFFECTING THE PATIENT'S DECISION TO INVOLVE A GENERAL PRACTITIONER

(a) Place where symptoms began

As might be expected, the place where the patient was taken ill played a major role in his or her decision to call a general practitioner. The place where symptoms began is known for 6338 (94%) of all admissions. For these patients, 80% were at home when symptoms started, 5% started, 5% were at work, and 15% were at other places away from home. 74·8% of those at home, 38·2% of those at work, and 40·4% of those at other places called their general practitioner.

If the symptoms began at home the call for help was made from home in 95% of cases. In the remainder, patients seem to have continued with their planned activities and then subsequently called from work, relatives, etc.

(b) Time of onset of symptoms

Among patients who could give a reasonably precise time of onset of symptoms the distribution of hour of onset showed a peak between 8 and 10 am. The data were not consistent with the hypothesis that major symptoms are equally likely to develop at any time of day ($p < 0{\cdot}01$). A similar pattern was observed both for all patients with suspected myocardial infarction and for those eventually shown to have a definite or probable infarction (fig 5) but there was also evidence that these patterns were not identical. The second peak seen in the evening was not found in the group with a definite infarct. Symptoms that develop in the mid-evening were less likely to be associated with a diagnosis of definite or probable infarction.

The decision to call a general practitioner was not directly associated with time of day, but because more people were away from home during the day the percentage calling a general practitioner varied from 57% when symptoms started in the early afternoon to 74% during the early hours of the morning. The time from onset of symptoms to admission was also associated with time of onset. A two-way analysis of variance applied to the log times suggests that the mean time to admission tended to be a little longer when symptoms started during the early hours of the morning but was relatively constant over the rest of the day. The effect of contacting a general practitioner increased the *mean* time to admission by a factor between 2·5 and 3, but this multiplier was constant over the day.

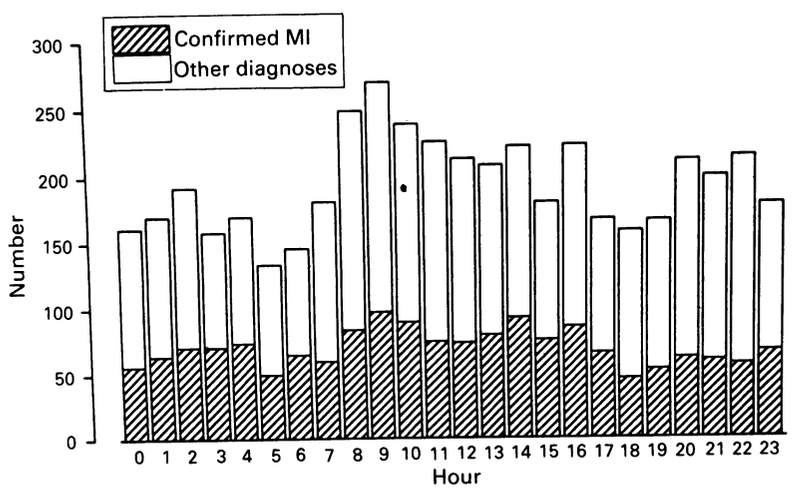

Figure 5 Classification of admissions by hour of onset of symptoms and eventual diagnosis.

DIAGNOSIS AND OUTCOME

Diagnosis and involvement of general practitioner

Table 1 shows the confirmed in-hospital diagnosis for those patients whose admission was arranged by a general practitioner and contrasts this with all other admissions. Overall there was a slight but significantly greater percentage of admissions with a definite or probable myocardial infarction in the patients referred by a general practitioner (35·1% *v* 30·4%, $p < 0{\cdot}0001$). However, as table 2 indicates, the accuracy of the general practitioner in identifying patients with myocardial infarction exceeds self selection only in the over 65 age group. The accuracy of general practitioners in the initial diagnosis may be due in part to the nature of the illness in the patients who choose to contact them. It was noted above that such patients are known to wait longer before calling for help than those who are admitted without contacting a general practitioner, suggesting differences in symptom pattern or severity between the two groups.

Table 1 Admission route and confirmed diagnosis (%)

Diagnosis	Admission arranged by general practitioner or deputising service (n=3929)	Other admissions (n=2390)
Definite MI	17·4	18·9
Probable MI	17·7	11·5
Possible MI	43·1	44·4
IHD	3·7	4·8
SINP	14·1	16·8
Other diagnosis	3·9	3·6

MI, myocardial infarction; IHD, ischaemic heart disease; SINP, suspected infarct not proven.

Table 2 Percentage of patients with definite or probable myocardial infarction by route of referral and age

Age	General practitioner or deputising service	Self
<45	21·5	22·8
45–54	31·6	33·4
55–64	37·5	36·6
65–74	39·4	30·8
>74	33·1	21·3

ADMISSION TO CORONARY CARE UNIT OR MEDICAL WARD

Although there were 13 coronary care unit beds available at the two hospitals, only 64·5% of all admissions were admitted direct to the coronary care units. Thirty eight percent of all patients admitted to a coronary care unit were eventually diagnosed as having a definite or probable myocardial infarction. Table 3 shows the proportion of patients admitted to a coronary care unit by age, sex, and eventual diagnosis. It shows that older patients were less likely to be admitted to a coronary care unit. Among the elderly, men were more likely to be admitted to the coronary care unit than women. This difference is apparent both in the group of patients who have a definite or probable myocardial infarction and in the group who go on to have other confirmed diagnoses.

Outcome

The case fatality rate in hospital for all admissions with suspected myocardial infarction was 931 of 6712 (13·9%). For patients with a diagnosis of definite or probable myocardial infarction the rate was 17%, compared with 12·3% for other diagnoses. Mortality in the possible myocardial infarction group was 14·2% and in the group in whom a suspected infarct was not confirmed it was 8·5%. Such rates were not unexpected, given the definitions for each diagnostic class. Most deaths in the groups with possible myocardial infarction and suspected infarct not proven were attributed to cardiac causes. However, electrocardiographic or enzyme evidence confirming infarction had not been obtained before death.

Information about survival, age, and referral to hospital was known for 6267 patients. As would be expected, fatality rates increased considerably with increasing age. There is no evidence, however, that route to hospital had an effect on case fatality for any age group.

The fatality rate for patients admitted to a coronary care unit was lower than for those admitted to a ward (11·0% compared with 18·7%) but the difference is mainly due to the different age structure of these groups. Table 4 shows mortality by age decades and coronary care unit/ward admission. Ward and coronary care unit fatality rates were almost identical through most of the age range but there was an increased mortality in the coronary care unit for patients over 75 years of age.

Effect of delay in hospital admission on outcome

It was difficult to assess the effect of time from onset of symptoms to hospital arrival on the eventual fatality rate in hospital as times were not available for many of the patients who died soon after admission. Hospital outcome could be related to the duration of symptoms before admission in 6318 patients, among whom the fatality rate in hospital was 12·7%. In contrast, the hospital fatality rate was 33·5% in the group of 379 patients for whom insufficient information was available.

Table 5 gives in-hospital mortality by time to admission for those patients who were able to provide the timing data. Delay in admission had very little effect except that there was a higher fatality rate among patients with a definite or probable infarct who were admitted late. For those with a pre-hospital illness lasting nine hours or less, the fatality rate in hospital was 13·1%, while for those with symptoms for more than nine hours it was 22·4%.

PATIENTS TREATED AT HOME

The domiciliary diagnostic service was offered to all 315 general practitioners in the Nottingham District Health Authority. In the three years 1982–84 inclusive, 97 general practitioners used it: 60 used it for five patients or fewer, seven for between six and 10 patients, and 30 for more than 10 patients.

The district nurses visited 381 patients to record an electrocardiogram and take blood samples for the estimation of cardiac enzymes. Definite or probable infarction was diagnosed in 62 patients (16·3%). Possible infarction was diagnosed in 179 (47·0%), ischaemic heart disease in 10 (2·6%), and suspected infarct not proven in 130 (34·1%).

In addition to these patients, a search of the records of the biochemistry departments showed that during these three years, blood samples from 968 patients had been sent by general practitioners for the estimation of cardiac enzymes. Although the age and sex were not always known, these patients were apparently somewhat younger than those seen by the district nurses. In 63 patients one or more enzymes were increased to twice the

Table 3 Percentage of patients admitted to coronary care unit by sex, age, and diagnosis

Age	Definite/probable myocardial infarction		Other diagnosis	
	Male	Female	Male	Female
<55	93·6	85·2	82·8	77·5
55–64	89·0	89·2	77·9	72·9
65–74	71·3	50·3	56·2	39·9
>74	28·6	18·3	24·1	11·7

Table 4 Percentage in-hospital fatality in each age group of patients admitted to coronary care unit or medical ward

Age	Patients admitted to: Coronary care unit	Ward
<55	3·9	3·8
55–64	9·4	9·3
65–74	19·1	19·2
>74	32·9	26·4

upper limit of normal, suggesting a diagnosis of probable infarction. In 342 patients, one or more enzymes were increased but to less than twice normal, making a diagnosis of possible infarction, and in 563 the cardiac enzymes were within the normal range.

During the single year 1984, 57 general practitioners in the Nottingham District Health Authority requested a domiciliary visit by a consultant physician to a patient suspected of having had a heart attack. No diagnostic information was available in these patients, but cardiac enzymes were not identified as having been requested in any of them. Eleven were admitted to hospital as an emergency as a result of the visit.

It is thus estimated that about 1500 patients with suspected myocardial infarction were treated at home by general practitioners during the three year period. Only 125 of these were known to have had a definite or probable infarction, however.

Discussion

The value of early specialised care for patients with heart attacks has been apparent since the development of the defibrillator. The demonstration that thrombolytic therapy is most beneficial when given soon after the onset of symptoms has provided another reason for rapid management decisions. The traditional role of the general practitioner as the patient's immediate source of help has to be reconsidered.

Our survey of patients with suspected myocardial infarction who were treated at home shows that this is a relatively uncommon practice even in our area, where the possibility of home care has been quite extensively investigated and discussed.[8] Our general practitioners made relatively little use of the diagnostic service provided by district nurses, and this was stopped at the end of 1984. Diversion of all the patients with definite or probable myocardial infarction from home to hospital care would have relatively little impact on the demand for hospital services, and from the end of 1984 we decided that there was little point in continuing to monitor patients treated at home. Clearly the main debate concerns the best way of arranging hospital admission.

Table 5 Percentage in-hospital fatality by time to admission

Time	All admissions	Definite/probable myocardial infarction
0–30 min	15·1	24·2
31–60 min	8·6	12·5
1–2 h	11·1	12·4
2–3 h	10·7	11·5
3–6 h	13·0	15·6
6–9 h	11·5	9·7
9–12 h	15·9	27·7
12–18 h	11·2	20·0
18–24 h	20·5	28·9
>24 h	15·7	20·6

We have shown that the median delay from onset of symptoms to hospital admission in the years 1982–84 was nearly three hours, and that there was little difference between subgroups of patients in terms of age, sex, or eventual diagnosis. The only fact that materially seemed to affect delay in admission was the patient's initial decision to call for an emergency ambulance direct or to seek help in the first instance from his general practitioner.

Given the size of the additional delay attributed to general practitioner involvement, the question arises whether this is biased in any way by the manner in which the data has been collected. It is accepted that most of the intervals were obtained via patient interviews and that such interviews miss patients who die in the first few days after admission. Table 5 shows that in-hospital fatality rates are effectively unrelated to time to admission although the observed rates are higher among patients admitted within 30 minutes. This finding, though not statistically significant, is consistent with an observation derived from the ASSET study[5] database that patients admitted within one hour have an increased risk of dying within one day, compared with patients admitted from two to five hours after onset of symptoms. Timing data is therefore more likely to be missing for very rapid admissions and this bias will increase the measurement of the times to admission, the effect being more marked in the self admission group. Our estimate of the additional delay attributed to general practitioner involvement is probably conservative.

We showed that patients who call for an emergency ambulance do so more quickly than those who call a general practitioner but our data do not point to any reason for this difference. It is possible that more severe symptoms tend to make patients summon an ambulance, but the proportion of patients eventually found to have a definite or probable infarction was essentially the same whatever the route of the call. General practitioners only seemed to admit to hospital a higher proportion of patients with definite or probable infarction than did 999 calls in elderly patients: this may indicate a reluctance to risk making an inaccurate diagnosis in the young. Our data suggest that the involvement of the general practitioner has little effect on outcome, though we have not been able to assess the value of pain relieving drugs given by general practitioners nor do we have data on patients seen by general practitioners because of chest pain but in whom myocardial infarction was not suspected.

Some of these data were used by the British Heart Foundation Working Party,[9] which concluded that there is little point—at least in an urban area—for thrombolytic therapy to be given either by general practitioners or by

ambulance crews. The median delay between the call for an ambulance and its arrival is only seven minutes, and the patient is in hospital 22 minutes later, so there is little to be gained from beginning treatment out of hospital. Thrombolytic agents can cause bradycardia and hypotension, and the danger of giving treatment immediately before an ambulance journey, coupled with the extra delays that such treatment involves, might well outweigh any benefit gained from earlier treatment. We accept, however, that the situation may be different in rural areas.

It is difficult to compare the different time intervals that contribute to the total period from onset of symptoms to hospital admission in our study with those of previous reports, because the data were collected in different ways, and in most studies there was no distinction made between calls made to a general practitioner or an emergency ambulance. However, a study of patients in Tower Hamlets found that 31% of patients had contacted their general practitioner within one hour of the onset of symptoms, and 46% by two hours; 45% of patients were in hospital within four hours.[10] In Teeside, the median interval between onset of symptoms and the call for a general practitioner was 71 minutes and a median of 74 further minutes elapsed before an ambulance was called.[11] In Doncaster, the median delay before the call for help was 110 minutes.[12] In Edinburgh, a median delay from onset of symptoms to hospital admission was 5 hours 23 minutes if a general practitioner was involved, but 2 hours 21 minutes for a group of 60 patients who called an emergency ambulance.[2] Though our register data suggest a long delay is associated with general practitioner calls, this is evidently not inevitable as it has been found that a rapid response is possible with careful organisation: in Grampian, 67% of 511 patients were reached by general practitioners within two hours of the onset of symptoms.[13]

Once the patient has arrived in hospital it is clearly immaterial whether he was admitted by a general practitioner or whether he summoned an emergency ambulance directly. Delay in hospital admission had no clear effect on in-hospital fatality, except that there was a higher fatality rate among patients whose admission was arranged after a very prolonged period and in whom complications had presumably already developed. It is, however, difficult to be certain about the effect of delay in calling for help, because when patients died soon after admission, data tended to be incomplete.

Despite the presence of seven and six coronary care unit beds respectively in the two hospitals, approximately one third of patients were admitted in the first instance to a medical ward. The similarity in fatality rates between groups of patients admitted to wards or coronary care units has been described previously,[14] but since we do not know how or why patients were selected for either form of management it would not be reasonable to infer that coronary care units provide little or no benefit.

Though it seems desirable to educate patients to call for help quickly and to call for an ambulance rather than a general practitioner, attempts to do so have had little success.[15] The greatest potential for reducing the delay in hospital admission lies in the 100 minutes that elapse between the call for a general practitioner and the call for the ambulance. General pracititioners should be prepared to make a diagnosis on the basis of information given to them by the patient on the telephone and unless they can reach the patient within 10 or 15 minutes they should send an ambulance. General practitioners, and the receiving staff in accident and emergency departments, will have to accept that the diagnosis will on occasion be wrong, and patients will have to accept that when a myocardial infarction is possible a visit by their general practitioner may not be appropriate.

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