

MEDICAL PRACTICE

Hospital Topics

Acute Myocardial Infarction in Doncaster I—Estimating Size of Coronary Care Unit

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Summary

A "no refusal" coronary care service (for one year) was offered to a selected sample of 10 general practices (total list 74,657). The patients were admitted to a three-bedded unit in Doncaster Royal Infirmary and data were collected to enable estimation of the size of unit necessary to serve the whole population in the area (census estimate 268,560; total G.P. list 315,811). This estimation was based on:

1. The frequency of admission to hospital of suspected acute myocardial infarction in one year, estimated at 978 from the total population.
2. The average duration of stay in the unit, which was 2.45 days.
3. The distribution of observed occupancy was approximately Poissonian.

From these the average expected bed occupancy was calculated as 6.56 and reference to probability tables gave the frequency of overload for different numbers of beds provided. The incidence of acute myocardial infarction in the area is estimated at 275 per 100,000 per annum, on calculations based on the practice list size, and at 323 per 100,000 per annum, on calculations based on census figures.

Introduction

It has been a widely held belief that management of acute myocardial infarction in a hospital coronary care unit results in a reduction of case fatality.¹⁻⁶ This has led to the establishment of coronary care units in many hospitals of the district general type, such as was opened at Doncaster in 1968. The interim provision of three beds for acute coronary care in the new intensive care ward provided an opportunity to collect information which might indicate the demand on hospital resources made by this service. As three beds were too few to offer a complete coronary care service to a population of over 250,000 we decided to limit the population served by the coronary care unit until the development of the new hospital was complete. To obtain the sort of experience of demand which would help to plan the permanent unit we offered a "no refusal" coronary care service to a stratified sample of general practices while making the usual ward facilities available to the rest. We planned to collect data for 12 months concerning occupancy and duration of stay in the unit which would enable us to calculate the size of a unit needed to cater for the total local population.

Method

SELECTION OF SAMPLE

All general practitioners in the area were sent a brief questionnaire asking the size of their list and whether they were for, against, or undecided about the value of hospital coronary care. They were asked to indicate their willingness or otherwise to collaborate in a scheme which required them either to send into hospital at once all cases of suspected myocardial infarcts or, if home management was preferred, to attempt to prove the diagnosis and fill in a data sheet. We selected 10 practices, representing about a quarter of the population. Selection was based on replies to our questionnaire together with such inform-

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ation as distance of practice from hospital, number of practitioners in the practice and their seniority, and the estimated frequency of mining as the occupation of the patients. We attempted to stratify the sample against these factors. Two additional practices were added to offset the unexpected withdrawal of any particular practice to make a total of 12 to be served by the scheme. Calculations, however, are based on the original sample of 10 practices.

OPERATIONAL POLICY

Patients with suspected acute myocardial infarction were accepted from the following three sources: general practices included in the sample, all patients attending the accident and emergency department thought to have myocardial infarction, and patients already in hospital for other reasons thought to have myocardial infarction.

Much importance was attached to the speed with which patients were admitted. In particular the selected practitioners were advised that they need not go to see a patient before referral if the history was typical. The ambulance service co-operated by giving priority to coronary care calls. On arrival at the accident and emergency department the patient was seen by a senior nurse and immediately transferred to the coronary care unit unless resuscitation was needed.

The diagnosis of acute myocardial infarction was regarded as proved if a history of pain was associated with typical E.C.G. changes and raised serum enzymes (creatinine phosphokinase or aspartate transaminase) measured on admission and 12 hours later. The diagnosis was considered unproved but likely when the E.C.G. changes were typical but information on enzymes was deficient. If in these circumstances the E.C.G. was normal the diagnosis was unproved and unlikely. Where all information was complete but negative the diagnosis was disproved.

Patients with proved and likely acute myocardial infarction were kept in the coronary care unit for 48 hours or, if any complication arose, for 24 hours after control of the complication. They were then transferred to the general ward and kept at rest for seven days from the onset then partially mobilized and discharged about 10 days from onset. Outpatient follow-up took place after six weeks. Patients with disproved or unlikely acute myocardial infarction were discharged home if possible.

Patients in the coronary care unit were under continuous E.C.G. surveillance and nurses regularly charted heart rate, ectopic beat frequency and quality, and blood pressure. Anti-arrhythmic drugs, especially lignocaine, were used as suggested by Aber *et al.*⁵

In the second six months of our study we computed the prognostic index devised by Norris *et al.*⁴

CORONER'S CASES

All coroner's necropsies in the area were performed in the hospital mortuary. With the willing co-operation of the morbid anatomist and his staff we were notified of all coroner's cases with a postmortem diagnosis of coronary thrombosis which occurred during the 12-month period. Details, with times, of the events preceding death were obtained in most of these cases, and the results are discussed in part II of this paper.

Results

During the 12 months' survey, from 1 October 1968 to 31 October 1969 (omitting April 1969, when the unit was closed for redecoration), 377 patients (72% males, 28% females) were admitted to the coronary care unit. About two-thirds came from general practice and one-third from the accident and emergency department (Table I).

There was wide variation in the rates of referral from general practice (Table II).

TABLE I—Admissions to Coronary Care Unit in 12 Months

	Males	Females	Total	
			No.	%
Patients from accident and emergency department	91	28	119	32
Patients from other wards	180	78	258	68
G.P. referrals				
Total	271 (72%)	106 (28%)	377*	100

* An additional 7 patients admitted to hospital with other diagnoses were found at necropsy to have a recent myocardial infarct. The hospital series thus totals 384.

TABLE II—Annual Referral Rates from some Practices in Doncaster and District

Practice No.	No. Referred	List Size	Referral (%)
1	40	19,644	2.04
2	8	11,300	0.71
3	46	10,073	4.56
4	24	9,175	2.62
5	7	6,416	1.09
6	23	6,030	3.81
7	14	11,760	1.19
8	25	8,123	3.08
9	15	3,982	3.77
10	19	5,060	3.73
11	29	5,761	5.04
12	8	959	8.35
Total	258	98,283	2.63

CALCULATION OF EXPECTED SIZE OF UNIT

Practices 1 and 9 were outside the stratified sample. After their subtraction from Table II it is shown that 203 cases of suspected myocardial infarct were referred to the coronary care unit in one year from a total practice list of 74,657—that is, 2.72 per 1,000 per annum.

As the total of all practice lists in the area served by the hospital was 315,811 the expected annual referral rate would be $315,811 \times 0.00272 = 859$. The total expected admissions to the unit in one year will be $859 + 119$ (from the accident and emergency department and from other wards; Table I) = 978.

The observed durations of stay in the unit were accurately recorded in the second half of our study and are shown in Fig. 1. The mean duration of stay was 2.45 days.

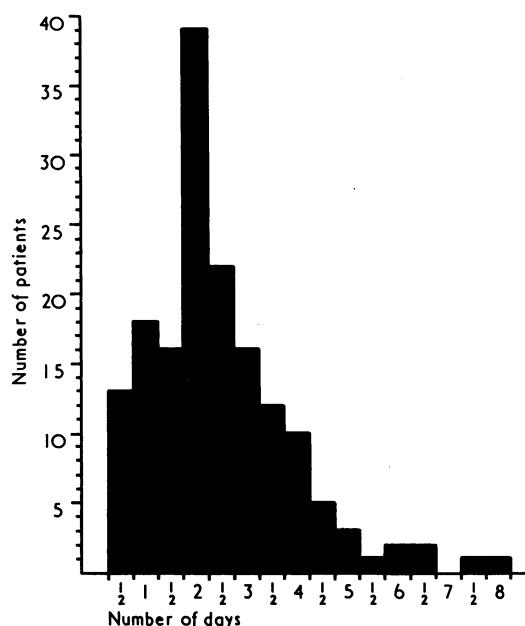


FIG. 1—Length of stay in Doncaster coronary care unit during May to October 1969 inclusive.

If 978 admissions are expected in one year then the average number of beds occupied each day will be

$$\frac{978 \times 2.45}{365} = 6.56.$$

The frequency distribution of different levels of occupancy observed in the unit matches quite well a theoretical distribution derived from Poisson tables. Reference to these tables for an average occupancy of 6.56 enables us to predict the frequency of overload of the unit for different numbers of beds provided. In the following example, the first figure indicates the number of beds provided and the second figure the percentage of requests for admission when the unit is full: 8, 21; 9, 12; 10, 7.

EXPECTED NUMBER OF GENERAL WARD BEDS

The average duration of stay of patients in the general ward after leaving the coronary care unit was 7.4 days—that is, 2.86 times the average duration of stay in the unit. We may therefore compute an expected occupancy of general ward beds of $2.86 \times 6.56 = 18.76$. This figure may be reduced by 10% because of patients dying in the unit and the result increased by 25%, as the usual general ward occupancy is 80%; this gives 21 beds needed to accept the transfers from the unit.

INCIDENCE OF ACUTE MYOCARDIAL INFARCTION

Altogether 62.8% of patients admitted to the unit had proved or likely acute myocardial infarction (Table III).

TABLE III—Diagnosis of Acute Myocardial Infarction in Coronary Care Unit Patients

Final Diagnosis	Proportion of Patients	
	No.	%
Proved	223	58.1
Likely	18	4.7
Unlikely	20	5.2
Disproved	123	32.0
Total	384*	100

* See footnote to Table I.

The age and sex distribution of patients with proved myocardial infarction admitted to the coronary care unit is compared in Fig. 2 with that of the coroner's pathologist's cases diagnosed at necropsy as coronary thrombosis during the same year. The peak incidence in men occurred in the age group 60-65 in the coronary care unit series and in the 70-75 group in the coroner's series. A greater proportion of patients were over 65 years of age in the coroner's series (53% of the men, 70% of the women) compared with the coronary care unit series (38% of the men, 54% of the women.)

In one year 144 patients with proved or likely acute myocardial infarction were found in the sample practices; total list 74,657. Also 67 proved or likely cases were referred from the accident and emergency department and from other wards—that is, from a population equal to the total of all practice lists (315,811). There were also 18 coroner's cases not in the care of a local doctor which were included on the assumption that a similar number of infarcts had occurred in emigrants from Doncaster during the same year. In addition there were 37 coroner's cases whose doctor was in the selected sample, but here the total list size was 67,705 because of the slight difference between the territories of the coroner's jurisdiction and certain peripheral practices.

The incidence of acute myocardial infarction may therefore be calculated as

$$\frac{144}{74,657} + \frac{67 + 18}{315,811} + \frac{37}{67,705} = 0.002746, \text{ or } 275 \text{ per } 100,000 \text{ per annum.}$$

The denominators of the above fractions are derived from the practice list sizes. The estimated total population of the same area is 268,560. based on census figures. An adjustment for list size inflation would be

$$\frac{275 \times 315,811}{268,560} = 323 \text{ per } 100,000 \text{ per annum.}$$

Discussion

The design of this study enabled us to collect information relevant to demands on the hospital service of the provision of coronary care in Doncaster and district. In selecting practices to be served by the pilot scheme we were concerned to choose a sample representative of the characteristics of all practices in the area so that we could "gross up" our experience with reasonable confidence. As expected this form of selection resulted in an uneven referral rate of suspected acute myocardial infarction. We expect a similar lack of uniformity when the service is expanded. The incidence of acute myocardial infarction determined from our sample must, however, be a low estimate, as possibly sample practices with a low referral rate contained undiagnosed or unreported cases occurring during the period of survey. On the other hand we would stress that there was no selection of cases by the hospital, especially no age limitation.

To estimate the load on the hospital of a coronary care service two pieces of information are essential: (1) the frequency of admission to hospital in one year of cases of suspected acute myocardial infarction, and (2) their average duration of stay in the coronary care unit. From our study in Doncaster and district we estimate that in 1968-9 978 admissions to the coronary care unit would have been requested from all general practices with a total list of 315,811. This gives an approximate referral rate of 310 per 100,000 per annum.

We found that the average duration of stay in the unit was 2.45 days using criteria for discharge recommended by Lawrie *et al.*³—namely, after 48 hours if uncomplicated or 24 hours after the end of any arrhythmia or other complication. Newell⁶ showed that emergency admissions to hospital follow a Poisson distribution, and we observed a similar phenomenon with our series of admissions to the coronary care unit. Having calculated from the above basic information the average

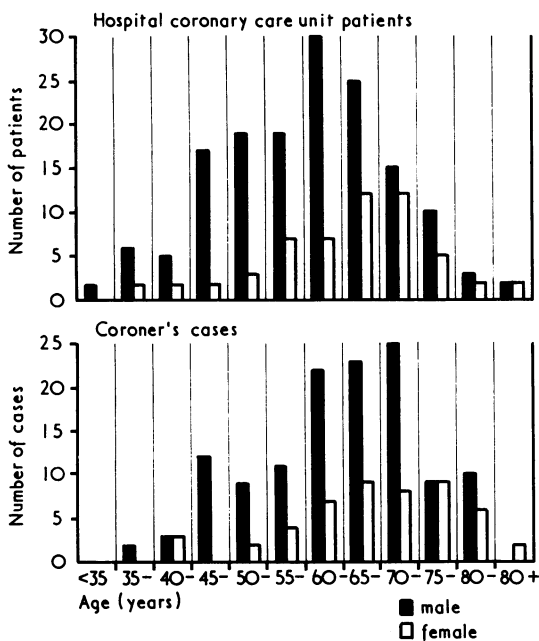


FIG. 2—Age and sex distribution of patients with acute myocardial infarction in Doncaster.

demand for admissions to the unit we referred to tables of Poisson probabilities to determine the frequency of overload with various levels of provision of beds above the calculated average.

There are obvious dangers in generalizing from the experience gained in a sample of the Doncaster population. Nevertheless, the approach to estimating the size of a coronary care unit described in this paper seems to have reasonably wide applicability.

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Acute Myocardial Infarction in Doncaster II—Delays in Admission and Survival

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Summary

The speed of admission of patients with suspected acute myocardial infarction was observed over a period of 12 months during which a "no refusal" coronary care scheme was functioning, with emphasis on minimizing delay. During the same period the duration of survival of cases diagnosed as coronary thrombosis by the coroner's pathologist was measured. Comparison of the two series shows that 75% to 80% of the coroner's cases had died before the median time of notification of the general practitioner by those patients referred to hospital.

We argue that the provision of mobile coronary care on request from general practitioners is unlikely to have an appreciable effect in preventing deaths from acute myocardial infarction outside hospital.

Introduction

It has been known for some time that death from acute myocardial infarction usually occurs in the first few hours after the onset of attack. McNeilly and Pemberton¹ studied survival of patients both in hospital and outside who were certified as dying of coronary artery disease or arteriosclerotic heart disease in Belfast. They showed that the median time of death lay between 3 hours 30 minutes after the onset of attack for men and 6 hours 18 minutes for women. This evidence laid greater stress on the need for speed in the provision of acute coronary care. It was with this in mind that we planned a prospective study of patients with proved or likely acute myocardial infarction in Doncaster (a) to determine the duration of the stages leading to admission to the coronary care unit (C.C.U.), and (b) to measure the survival times from the onset of attack in fatal cases either in hospital or outside and reported to the coroner. Finally, we hoped to obtain some guidance about the possible impact of a coronary ambulance on mortality in Doncaster.

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Method

Patients included in this study were drawn from two sources—(a) admissions in one year to the hospital coronary care unit from 10 selected practices utilizing a "no refusal" service, as described in part I of this paper; and (b) all cases in the same year diagnosed as coronary thrombosis or occlusion at necropsy by the coroner's pathologist in Doncaster. Details, with times, of the events preceding death were obtained in most of these cases from the relatives, general practitioner, or coroner's officer.

Results

ADMISSION TO CORONARY CARE UNIT

Despite attempts to speed up admission of cases described in part I of this paper the median time of admission was 3 hours 22 minutes after the onset of attack. The times of the various stages before admission are shown in Table I.

The greatest delay was due to patients, half of whom waited 1 hour 50 minutes or more before requesting medical assistance. This delay was minimal in 15% who notified within 15 minutes and maximal in 18% who waited eight hours or more. In contrast the ambulance services moved with gratifying speed,

TABLE I—Distribution of Cases by Time Intervals between Onset of Attack of Chest Pain and Admission to Coronary Care Unit

Time Interval (hours)	(1) Attack to C.C.U.		(2) Attack to Notification of G.P.		(3) Attack to Ambulance Called		(4) Ambulance Called to Collection		(5) Collection to Delivery at A.E.D.		(6) A.E.D. to C.C.U.	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
< 1/4	36	10.3	68	15.0	30	9.3	183	55.1	210	63.3	192	53.5
1/4 - 1/2			31	6.8	25	7.8	113	34.1	106	31.9	87	24.2
1/2 - 3/4			64	14.1	39	12.1	32	9.6	16	4.8	53	14.7
3/4 - 1	71	20.3	78	17.1	51	15.8	4	1.2			22	6.2
1 - 2	53	15.1	42	9.2	41	12.7					4	1.1
2 - 3	41	11.7	32	7.0	18	5.6					0	
3 - 4	18	5.1	11	2.4	10	3.1					0	
4 - 5	15	4.3	25	5.5	17	5.3					1	0.3
5 - 6	15	4.3	9	2.0	12	3.7						
6 - 7	11	3.1	15	3.3	7	2.2						
7 - 8	59	16.6										
8 - 24	17	5.1	80	17.6	72	22.4						
24 - 48	5	1.5										
48 - 96	9	2.6										
Total	350	100	455	100	322	100	332	100	332	100	359	100
Median	202 min*		110 min		143 min		13 min		12 min		14 min	

*Note that the sum of the medians calculated for columns 3, 4, 5, and 6 is different from the median of the measured interval between attack and admission to C.C.U. (column 1). This is to be expected.
A.E.D. = Accident and emergency department.