Prognosis of patients with acute myocardial infarction admitted to a coronary care unit

I: Survival in hospital

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On a basis of history, clinical examination, and the electrocardiogram it was possible to identify groups of patients with acute myocardial infarction with good and bad prognoses as regards hospital survival. Individual adverse factors were age, previous history of ischaemic heart disease, anterior infarction, persistent sinus tachycardia, pulmonary crepitations, hypotension, and raised venous pressure. Multivariate analysis showed four factors remaining significant—age, tachycardia, hypotension, and pulmonary crepitations. As a result of treatment of cardiac arrest, hospital mortality, which would otherwise have been 20 per cent, was 17 per cent. Preceding unstable angina did not worsen the immediate prognosis.

With the opening of a coronary care unit in this district general hospital in 1966, a prospective study was planned of factors affecting survival of male patients with acute myocardial infarction. Patients were admitted to the study during the 3 years 1966 to 1969 and followed up subsequently for periods of up to 7½ years.

Patients and methods

Of 872 male patients under 70 years admitted to the unit, 508 had acute myocardial infarction confirmed on a basis of two or more of the following criteria:—(1) History of severe central chest pain lasting for more than 2 hours; (2) classical electrocardiographic abnormalities of recent infarction, or ST-T changes and increase in blood AST level; (3) left bundle-branch block and rise in blood AST level. Some patients who died early after admission were included on necropsy evidence only. The remainder had angina (143), other cardiovascular conditions (104), and miscellaneous respiratory, gastrointestinal, or musculoskeletal pains. The clinical features of patients included in the study are shown in Table 1.

Local general practitioners were approached and invited to seek admission directly to the unit of all patients suspected of having sustained a recent infarct. Doctors and nurses working in the unit used an agreed therapeutic schedule. Patient data were

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recorded on specially designed proformata. Patients were treated in the unit for periods of 2 to 10 days (average 4). The estimated interval between the onset of infarction and admission to the unit was under 6 hours in 56 per cent, 6 to 24 hours in 28 per cent, and over 24 hours in 16 per cent. The mean time was 4 hours. Serial data recorded included heart rate, blood pressure, fluid balance, occurrence of arrhythmias, clinical observations of venous pressure, pulmonary crepitations, auscultatory findings in the heart, and complications.

Results

(1) DEATHS IN HOSPITAL

Sixty-four patients (12.6%) died in the coronary care unit and a further 24 (4.7%) during the remainder of their hospital stay. Total hospital deaths were therefore 88 or 17 per cent of patients admitted. Mortality was significantly related to several factors determined at the time of admission (Table 1). Age 60 or over, a low systolic blood pressure or sinus tachycardia maintained over 4 hours, increased venous pressure, and pulmonary crepitations were all associated with a higher mortality rate. A previous history of ischaemic heart disease also indicated a poorer hospital prognosis especially if the patient had had a previous infarct but gave no history of angina. The fact that heavy smokers had a significantly lower hospital mortality may be partly explained by the

tendency for heavy smokers to be younger (69% aged under 60, versus 52% of the other patients).

A multivariate analysis, using linear logistic regression (Cox, 1970), was carried out in order to assess simultaneously the prognostic value of all these factors. This analysis shows that only 4 factors then have statistically significant regression coefficients; these are high pulse rate ($P < 0.001$), low blood pressure ($P < 0.01$), pulmonary crepitations ($P < 0.02$), and age over 60 ($P < 0.01$). It is of interest to note that the initial clinical assessment by the attending physician at the time of admission was a very reliable prognostic indicator with only 4 per cent of patients with 'good prognosis' dying in hospital compared with 67 per cent of those with 'poor prognosis'.

Premonitory symptoms

Unstable angina in the period 2 months to 1 day preceding infarction was reported by 37 per cent. This group of patients had hypotension significantly less commonly after infarction (46% versus 57%; $P < 0.05$) and more often gave a family history of ischaemic heart disease (37% versus 26%; $P < 0.05$). They did not have a significantly higher mortality (Table 1; Fulton *et al.*, 1972).

Anterior myocardial infarction

Patients with anterior infarction had a higher mortality than those with inferior infarction (Table 2). Anterior infarction was significantly associated with sinus tachycardia (46% versus 33%; $P < 0.005$) and presence of a third or fourth

Table 1 Hospital mortality and patient characteristics on admission

Characteristic	Level	No. of patients	No. (and %) dying in hospital	P value*
All patients		508	88 (17%)	
Age (y)	< 40	20	0 (0%)	< 0.001
	40-49	87	11 (13%)	
	50-59	188	23 (12%)	
	60-69	193	48 (25%)	
	70+	20	6 (30%)	
Previous history of ischaemic heart disease	None	231	27 (12%)	< 0.001
	Angina only	139	27 (19%)	
	Infarct only	46	15 (33%)	
	Both infarct and angina	92	19 (21%)	
Preinfarction crescendo angina	No	320	57 (18%)	NS
	Yes	188	31 (16%)	
Previous history of hypertension	No	442	71 (16%)	NS
	Yes	61	14 (23%)	
Family history of ischaemic heart disease		5	3	NS
	No	322	51 (16%)	
	Yes	140	16 (11%)	
	Unknown	46	21	
Smoking history	Non-smoker	113	21 (16%)	= 0.05
	Moderate	164	27 (16%)	
	Heavy	202	22 (11%)	
	Unknown	29	18	
Delay in admission	< 6 hours	286	50 (17%)	NS
	6-24 hours	141	26 (18%)	
	24+ hours	81	12 (15%)	
Lowest systolic BP (mmHg) > 4h	≥ 100	237	25 (11%)	< 0.001
	< 100	271	63 (23%)	
Highest pulse rate > 4h	≤ 100	306	37 (12%)	< 0.001
	> 100	202	51 (25%)	
	Unknown	330	50 (15%)	
Third or fourth heart sound	No	163	27 (17%)	NS
	Yes	15	11	
	Unknown	440	65 (15%)	
Mitral systolic murmur	No	53	12 (23%)	< 0.1
	Yes	15	11	
	Unknown	308	41 (13%)	
Raised venous pressure	No	190	40 (22%)	< 0.01
	Yes	10	7	
	Unknown	247	23 (9%)	
Pulmonary crepitations	No	250	58 (23%)	< 0.001
	Yes	11	7	
	Unknown	291	55 (22%)	
Obesity	No	199	29 (19%)	NS
	Yes	18	4	
	Unknown	260	11 (4%)	
Initial clinical assessment	Good	164	21 (13%)	< 0.001
	Fair	84	56 (67%)	
	Poor			

*Significance levels based on standard χ^2 tests for comparison of percentages except for age when a test for trend in percentage was used.

Table 2 *Electrocardiographic abnormalities and hospital mortality*

		No. of patients	No. (and%) dying in hospital	P value
Position	Anterior	258	45 (17%)	0.02
	Inferior	220	23 (10%)	
	None/unknown	30	20	
Q wave	Yes	347	55 (16%)	0.08
	No	135	14 (10%)	
	Unknown	26	19	

heart sound (38% versus 25%; $P < 0.05$) while inferior infarcts were associated with venous pressure increase (45% versus 34%; $P < 0.05$).

Transmural infarction

Presence of pathological Q waves was associated with sinus tachycardia (46% versus 30%; $P < 0.005$) and arrhythmias (42% versus 28%; $P < 0.005$). It was commoner in inferior than in anterior infarcts (50% versus 39%; $P < 0.1$). There was a marginally significant difference, however, as regards survival in hospital, compared with patients with intramural infarction (Table 2).

(2) COURSE IN HOSPITAL

The frequency of various clinical observations in patients in the coronary care unit is shown in Table 3.

Arrhythmias

Arrhythmias (excluding asystole) requiring treatment according to defined criteria occurred in 39 per cent of cases. The order of frequency was persistent ventricular extrasystoles, ventricular fibrillation, atrial fibrillation or flutter, atrioventricular block, sinus bradycardia, atrial tachycardia, and ventricular tachycardia. Arrhythmias were significantly commoner in patients with a previous infarct (50% versus 36%; $P < 0.005$) and in patients

with pulmonary crepitations and hypotension (49% versus 28%; $P < 0.001$). Atrioventricular block was commoner in inferior than in anterior infarcts (8% versus 1%; $P < 0.001$). Sinus bradycardia did not predispose to ventricular arrhythmias or worsen prognosis (Table 1; Epstein *et al.*, 1973).

Cardiac arrest

Cardiac arrest occurred in 85 (17%) of cases, 38 from ventricular fibrillation and 47 from asystole. Only 2 patients with asystole were successfully resuscitated. Twenty-three patients with ventricular fibrillation were resuscitated, but of these only 12 survived to leave hospital. The majority of arrests occurred in patients with a combination of pulmonary crepitations and hypotension, and this group (145 in number) had a high hospital mortality of 30 per cent. Only 14 out of the 44 patients in this group who arrested were resuscitated, and none survived to leave hospital.

Time of onset of symptoms

Where admission to the coronary care unit was delayed beyond 6 hours after the onset of symptoms the frequency of cardiac arrest fell from 19 per cent to 4 per cent and of death in the coronary care unit from 14 per cent to 11 per cent. This presumably reflects the high early mortality from arrhythmia. In the few cases where admission was delayed beyond 24 hours the figures were 10 per cent and 7 per cent, respectively. However, there was no significant effect of delayed admission on overall hospital mortality (Table 1).

AST levels

These appeared to relate well to other measures of severity. Of 144 patients with AST greater than 100, 48 per cent had persisting sinus tachycardia, 62 per cent had hypotension, and 46 per cent had raised venous pressure compared with 36 per cent, 45 per cent, and 35 per cent, respectively, of 302 patients with lesser levels of AST ($P < 0.1$, 0.001, 0.05). Higher levels were commoner in transmural than in intramural infarcts (36% versus 19%; $P < 0.005$).

Table 3 *Frequency of complications*

Frequency of complications	
Persistent sinus tachycardia	47%
Hypotension (< 100 mmHg)	47%
Cardiac failure—triple rhythm	32%
venous pressure +	37%
pulmonary oedema	30%
Mitral systolic murmur	10%
Arrhythmia requiring treatment	39%
supraventricular	16%
ventricular (not VF)	15%
bradyarrhythmia	7%
Cardiac arrest—85 cases of whom 25 survived	17%

Discussion

The present survey confirms the findings of others as regards the unfavourable effects on immediate mortality in the coronary care unit of increasing age and signs of heart failure or hypotension, and the neutral effects of previous high blood pressure, pre-infarction crescendo angina, and obesity.

In some respects differences were found. Anterior infarcts were related to a higher mortality than inferior, confirming the finding of Norris *et al.* (1973) and at variance with those of Doscher and Poindexter (1950) and Beard *et al.* (1960). Norris *et al.* found a difference between transmural and intramural infarction, whereas Scheinman and Abbott (1973) did not; the present study gave only marginal support to the former. A past history of angina had an unfavourable effect in this study as in the series of Doscher and Poindexter (1950), Frank *et al.* (1973), and Norris *et al.* (1973), while Kannel and Feinleib (1972) and Chapman (1972) have found no such adverse effect. However, the present study showed that a previous infarct without angina led to an even worse prognosis.

It has to be said that the number of lives saved by electrical treatment of cardiac arrest was small (3%) in relation to the total number of patients. Clearly, however, an additional unknown number of patients may have been saved in the coronary care unit by prophylactic treatment of arrhythmia and early treatment of cardiac failure.

It would be useful to identify categories of patients with myocardial infarction who have a good prognosis and who would not benefit significantly from treatment in a coronary care unit. In this series the number of hospital deaths together with successfully treated cardiac arrests which would have been fatal outside hospital represented 20 per cent of all cases. Review of the data shows that subgroups might have been identified on a basis of data available at the time of admission who proved to have a lower risk of cardiac arrest and death, the main factors being a younger age, absence of past history of angina or infarction,

absence of pulmonary crepitations or hypotension, and a heart rate below 100 per minute. For example, of the 101 patients aged under 60 with no hypotension and no previous infarct only 7 per cent died or had a cardiac arrest in hospital.

The design of this study included an estimate of prognosis by the admitting registrar on the basis of history and examination. This proved a surprisingly accurate indication of the risk of dying from acute infarction.

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