EXPERIENCE IN THE TREATMENT OF ACUTE MYOCARDIAL INFARCTION IN A CORONARY CARE UNIT

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SYNOPSIS

The Coronary Care Unit (CCU) of the University Department of Medicine (II) at the Singapore General Hospital first started in April 1967. From then till the end of 1976, there has been a progressive yearly increase in the number of acute myocardial infarction (AMI) cases treated in the Unit. An analysis has been made of the last 400 cases of AMI which were treated in the CCU from March 1975 to the end of December 1976. Where possible, the data from these 400 patients are compared to those from an initial series of the first 339 patients (from April 1967 to the end of 1969) analysed several years ago.

There were 327 male and 73 female patients giving a male to female ratio of 4.5:1. Eighty-five percent of the patients were between 40-69 years, and 5% were at or below 40 years. The Indians were found to have a six fold increased propensity of suffering from AMI compared to the Chinese, Malays and others.

There has been an increase in the percentage of patients who were admitted into the CCU within the first 4 hours after the onset of chest pain — 45% — compared to the figure of 25% in the 1967/1969 series. The percentages of patients belonging to the 3 grades of severity viz. Grade I, II & III, have remained unchanged.

A detailed analysis of the incidence of the various cardiac arrhythmias, their treatment and their outcome is presented. There has been a marked improvement in the salvage of ventricular fibrillation in the present series — mortality 42% compared to the early series where the mortality was 78%. The mortality rate has also fallen in Gd I and II cases in the present series compared to the early series, (from 3% to 0.5% in grade I cases and from 25% to 8% in grade II cases). The mortality rate for grade III patients (ie those with cardiogenic shock) has increased from 69% to 84%. The salvage of ischaemic myocardium and the continuing search for an effective treatment for severe pump failure remains the greatest challenge in the present and future management of AMI.

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INTRODUCTION

The coronary care unit (CCU) of the University Department of Medicine (II) (formerly known as Medical Unit II) at the Singapore General Hospital was first started in April 1967. Initially, it was a modest 2-bed unit which was subsequently increased to 4 beds in 1969. The present unit, which consists of 6 beds, was opened in December 1973.

This paper analyses the experience accrued from the treatment of the last 400 consecutive patients suffering from acute myocardial infarction admitted to the CCU from March 1975 to the end of December 1976. Where possible, the results of these 400 patients are compared with the published data from an earlier series of the first 339 patients treated in the CCU (from April 1967 to the end of December 1969), when it first started about 8 years earlier.

PATIENTS AND METHODS

The CCU admits and treats all cases of suspected acute myocardial infarction (AMI) and serious cardiac arrhythmias admitted in the University Department of Medicine (II). In addition, certain complicated cases are referred from other units in the Singapore General Hospital and from the other hospitals in Singapore for management. The ECG's of all patients are routinely monitored continuously. The BBL system of ECG monitoring was used initially. From 1971 onwards, the ECG has been monitored using electrode leads attached below both clavicles and on both sides of the mid-abdomen employing lead II. The ECG is continuously displayed on an oscilloscope at the bedside of each patient. The ECG's of all patients are also simultaneously displayed on a large television osciliscope at the nurse's station. A rate triggered alarm system is used for the detection of cardiac arrhythmias. Hourly ECG strips are routinely recorded and also at any other time when the nurse observed an important cardiac arrhythmia.

RESULTS

Figures 1 and 2 show the total number of all cases and the cases of confirmed acute myocardial infarction respectively, treated yearly in the CCU from 1968 through 1976.

For the rest of this paper, an analysis of the last 400 cases which were treated in the CCU from March 1975 to the end of December 1976 is presented. All data henceforth given refers to these 400 patients unless stated otherwise. Where possible, the data from these 400 patients are compared with those from an earlier series of the first 339 patients treated in this unit (from April 1967 to the end of the 1969) analysed by Wan and his associates in 1970.

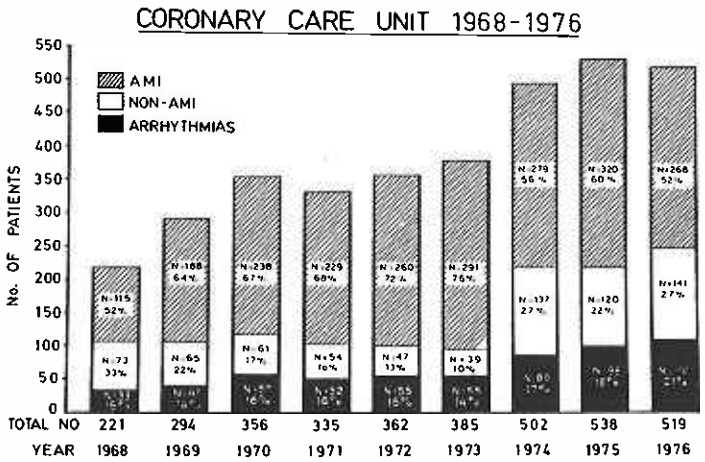

Fig. 1 Chart showing total number of all cases treated in the CCU from 1968 through 1976. AMI = Acute myocardial infarction cases. NON AMI = Non acute myocardial infarction cases. The percentages given in each box represent the percentages of cases in that group relative to the total number of cases treated in that particular year (see text).

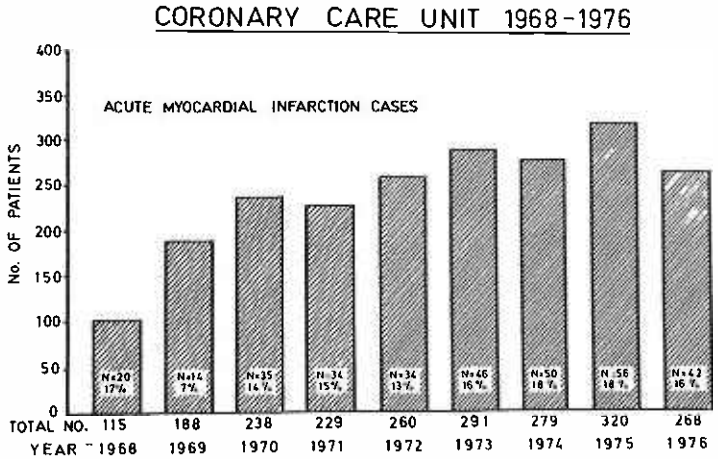

Fig. 2 Chart showing the number of cases of confirmed acute myocardial infarction treated yearly. The percentages in each column refer to the mortality rates as seen in the CCU (see text).

Table 1 shows the sex distribution and Fig. 3 is a histogram of the age distribution of the patients. Figure 4 shows the incidence of acute myocardial infarction amongst the three major ethnic groups in Singapore — Chinese, Indian and Malays — in terms of absolute numbers and also in terms of percentages relative to their percentage composition in the population. Figure 5 illustrates the so called "onset to monitoring time" in this present series of 400 patients compared to the earlier series of 339 patients. Figure 6 shows the percentages of patients belonging to the 3 grades of severity of acute myocardial infarction. Figure 7 illustrates the total number of hours of monitoring in the CCU. Table 2 shows the sites of infarction and Table 3 and 4 the incidence of supra-ventricular arrhythmias, ventricular arrhythmias and intra-ventricular conduction defects observed.

Table 5 shows the incidence of complete heart block and the mortality rate ratio of this complication. Table 6 shows the incidence of ventricular fibrillation and its outcome. Table 7 shows the mortality rate relative to the ages of the patients. Figure 8 highlights the mortality rates in the three grades of myocardial infarction.

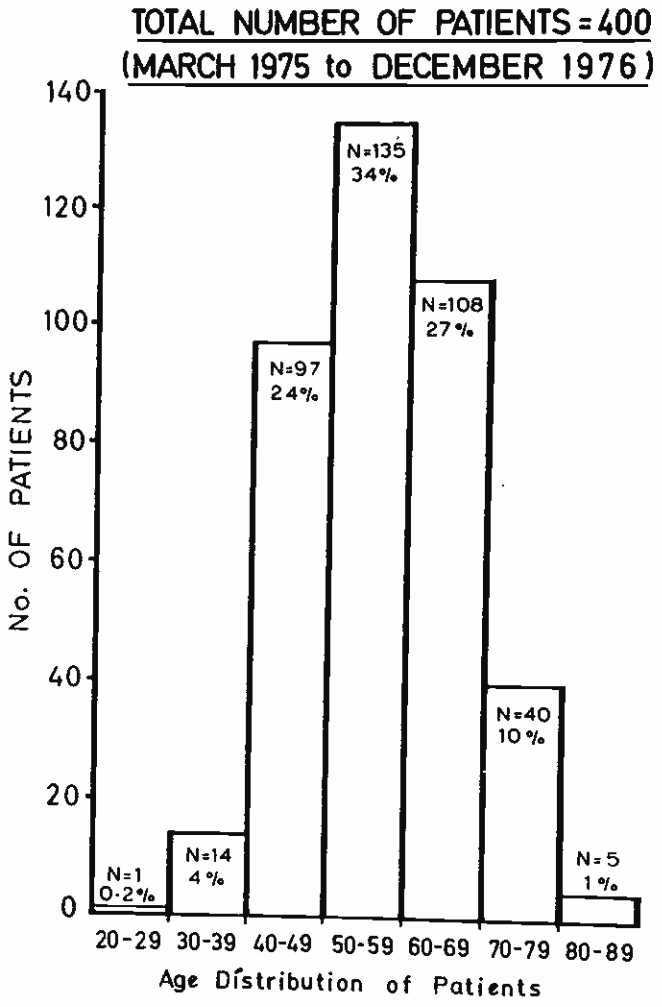

Fig. 3 Histogram showing age distribution of patients (see text).

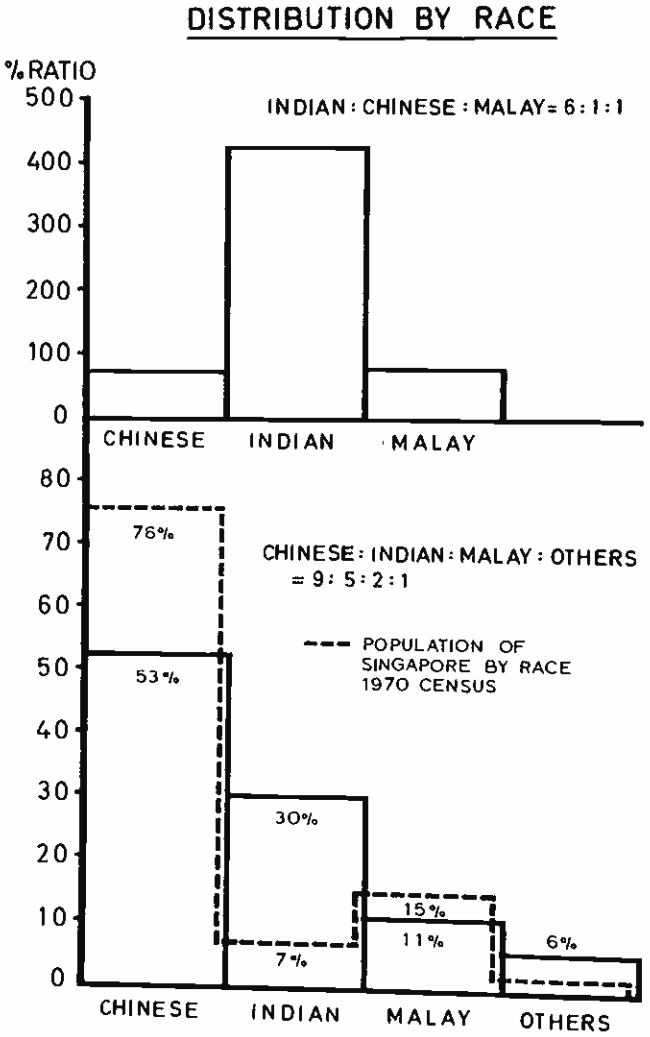

Fig. 4 Chart showing the incidence of acute myocardial infarction in Chinese, Indian, Malay patients and others (see text).

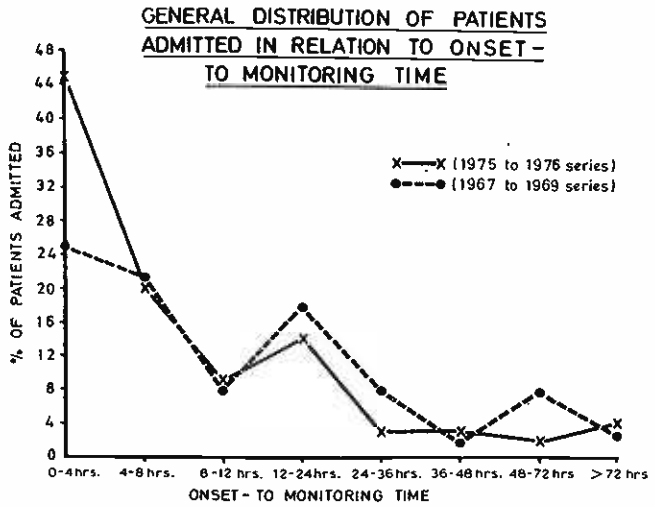

Fig. 5 Chart showing general distribution of patients admitted in relation to onset — monitoring time (see text).

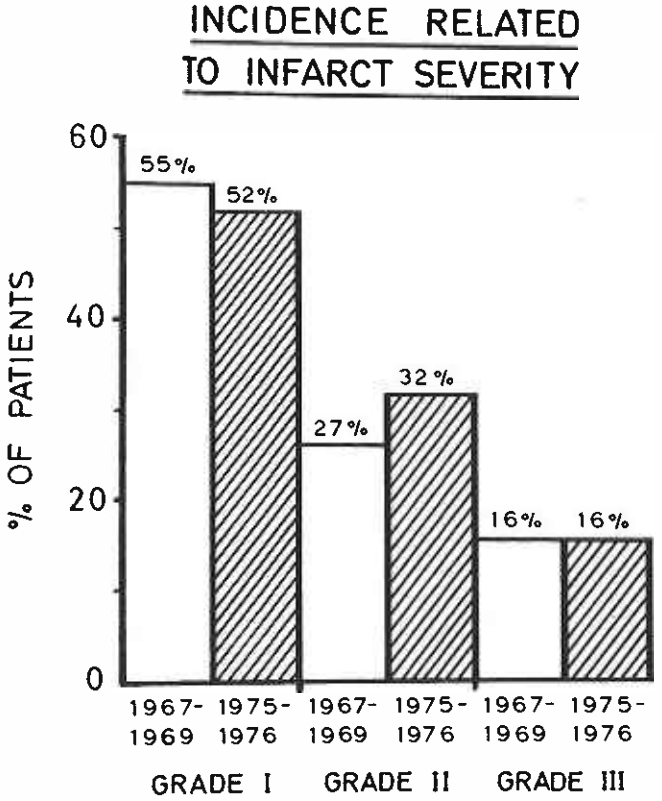

Fig. 6 Histogram showing the incidence of patients in the 3 grades of severity of acute myocardial infarction (see text).

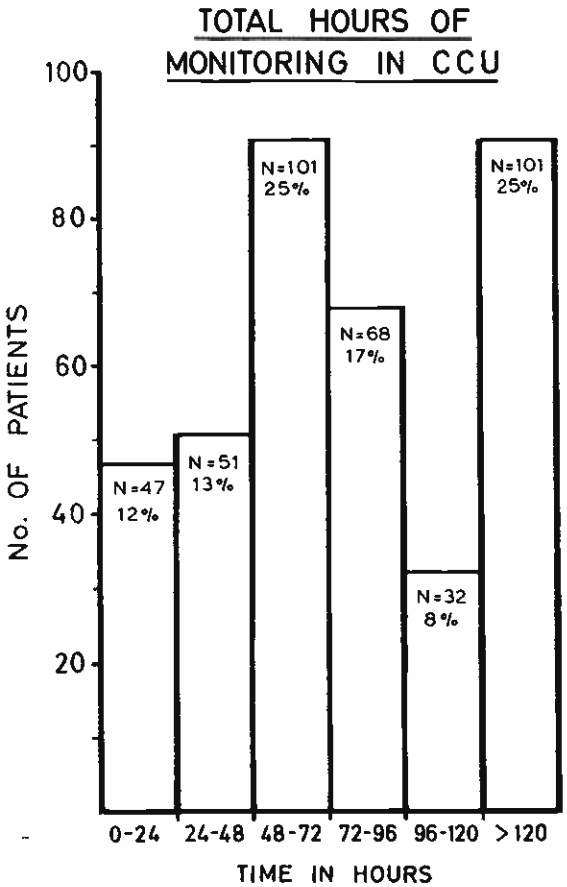

Fig. 7 Histogram showing the total hours of monitoring in the CCU (see text).

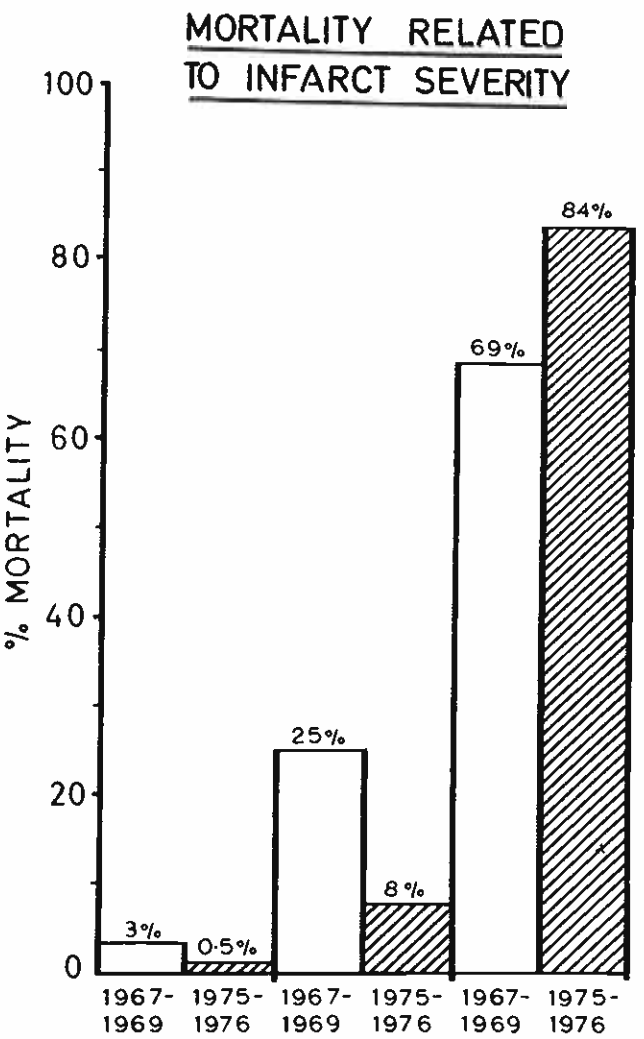

Fig. 8 Histogram showing mortality rates relative to severity of infarction.

TABLE 1

MALE	327
FEMALE	73
TOTAL	400
MALE : FEMALE RATIO	4.5 : 1

TABLE 2

SITE OF INFARCTION (400 PATIENTS)

	ANTERIOR	INFERIOR	ANTERIOR & INFERIOR	"TRUE" POSTERIOR	SUBENDO-CARDIAL	OTHERS
NO. OF PATIENTS	213	108	39	2	36	2
% OF PATIENTS	53%	27%	10%	0.5%	9%	0.5%

TABLE 3

INCIDENCE OF CARDIAC ARRHYTHMIAS : 244/400 (61%)

SUPRAVENTRICULAR ARRHYTHMIAS

	NO. OF PATIENTS	%
S.A. BLOCK	9	2
S.A. ARREST	3	0.8
S.V. TACH.	9	2
S.V. EXTRASYSTOLES	55	14
ACCEL. JUNCT. TACH.	4	1
A. FIB.	21	6
A. FLUTTER	13	4

TABLE 4

VENTRICULAR ARRHYTHMIAS & I.V. CONDUCTION DEFECTS

	NO. OF PATIENTS		%	
VENT. EXTRASYSTOLES	138		35	
EXTRASYST. V. TACH.	22	29	6	8
ACCEL. I.V. TACH.	7		2	
VENT. FLUTTER	1		0.3	
VENT. FIB.	24		6	
1st° HT. BLOCK	4		1	
2nd° HT. BLOCK (TYPE 1)	13	16	3	4
2nd° HT. BLOCK (TYPE 2)	3		0.8	
3rd° HT. BLOCK	33		8	
RT. B.B. BLOCK	29	37	7	9
LT. B.B. BLOCK	8		2	

TABLE 5

COMPLETE HEART BLOCK

INCIDENCE: 33/400 (8%)

	ANTERIOR	INFERIOR
NO. OF PATIENTS	15	18
NO. OF PATIENTS PACED	14	14
NO. OF DEATHS	6	6
MORTALITY RATE RATIO	40%	33%

TABLE 6

VENTRICULAR FIBRILLATION

INCIDENCE: 24/400 = 6%

	GRADE I	GRADE II	GRADE III	TOTAL
NO. OF PATIENTS	4 (16%)	11 (46%)	9 (38%)	24
NO. OF DEATHS	0	2	8	10
MORTALITY RATE RATIO	0%	18%	89%	42%

TABLE 7

MORTALITY IN RELATION TO AGE (400 PATIENTS)

AGE GROUP	30-39	40-49	50-59	60-69	70-79	80-89
NO. OF PATIENTS	14	97	135	108	40	5
NO. OF DEATHS	1	12	20	25	7	1
MORTALITY RATE %	7	12	15	23	18	20

DISCUSSION

The number of cases treated yearly in the CCU has increased steadily from 1968 onwards: eg. in 1968 — 221 cases and in 1976 — 591 cases (Fig. 1). On the average, about 15 to 20% of the total number of the cases treated were for cardiac arrhythmias, another 50 to 70% for AMI, and about 10 to 30% for chest pain which was initially diagnosed as suffering from AMI on admission but which was subsequently unconfirmed. Most of the last group of patients actually had chronic ischaemic heart disease.

Analysing only the confirmed cases of AMI, the same trend of increase with regard to the number of cases treated yearly in the CCU was also observed. (Fig 2). This can be attributed to either an actual increase in the incidence of AMI in Singapore or more likely to an increase in the number of cases referred to this unit as it became better established and more widely known through the years to both doctors and patients. The percentage mortality occuring in the CCU in our AMI cases averages 16% per year (Fig. 2). This figure is comparable to the results of most overseas centres.

For the rest of this paper, the results of the analysis of the last 400 cases which were treated in the CCU from March 1975 to the end of December 1976 will be discussed. Where possible, the data from these 400 patients are compared with those from an initial series of the first 339 patients (from April 1967 to the end of 1969) which were analysed several years ago.[1]

The 400 patients consisted of 327 males and 73 females, giving a male to female ratio of 4.5:1. This preponderance of males in AMI is in accord with universal experience. About 85% of our patients were between 40 — 69 years with the majority over the decade 50-59. Five percent of our infarct population were at or below 40 years old — the so-called "young coronaries".. Hence, although AMI is uncommon below the age of 40 years, it is by no means rare.

Since there are three main ethnic groups, namely the Chinese Malays and Indians living in Singapore, this island offers outstanding opportunities for the epidemiological studies on the differences in disease patterns amongst these 3 groups all living under the same roof. The population in Singapore comprises 76% Chinese, 15% Malays, 7% Indo-Pakistanis and 2% others (including Europeans, Eurasians, etc).

In this series, the relative incidence of AMI amongst Chinese, Indo-Pakistanis, Malays and others was 9 : 5 : 2 : 1. If we divide the percentage incidence of AMI of each ethnic group by the percentage composition of that particular group in the population, the upper chart in Figure 4 is obtained. It is clear that the Indians in Singapore have a six-fold increased propensity of suffering from AMI when compared to the Chinese or Malays — an observation which was made as early as 1950 in Singapore, but which still remains unexplained till today. It was initially believed that the Indians in Singapore suffer from a higher incidence of coronary artery disease chiefly because of a diet which is high, in cholesterol content. However, studies done by Lim and his associates on survivors of AMI seen in the CCU reveal that the serum cholesterol level in the Indian, Chinese and Malay patients show no significant differences (Lim et al 1975).

Figure 5 illustrates the so-called "onset to monitoring time" — the time interval taken by patients to be admitted to the CCU after they experience chest pain. It is clear that there has been a considerable increase in the number of patients admitted within the first 4 hours between 1975 to 1976 (45%) compared to the 1967-1969 period (25%). One of the reasons for this improvement could be a greater awareness of the population in Singapore in general during the past few years regarding heart diseases. This is indeed an encouraging trend because death is highest during the first few hours following AMI. Most of these deaths are due to ventricular fibrillation and are potentially salavageable if the patients are already in hospital.

We have used a simple classification for the severity of the infarction according to Robinson and Sloman (1969). The infarct is classified as grade I when it is uncomplicated, grade II when associated with congestive cardiac failure, grade III when complicated by cardiogenic shock. Of our 400 cases, 52% were in the grade I class, 32% in the grade II class and 16% were in the grade III class. There has been little change with regard to the percentage of the various grades of infarct cases, compared to the 1967-1969 series. (Fig 6). The therapeutic regime of cardiogenic shock in the CCU consists of intravenous infusions of various different phamacological agents, particularly Ethyl Adrianol ("Efforil").

It is the policy of our CCU to monitor uncomplicated cases for about 72 hours. Sometimes, cases are kept longer in the CCU because of the ready availability of beds or because of complications such as the persistence of malignant arrhythmias or heart failure. About 42% or a little less than half of our patients were monitored from 48-96 hours (Fig 7).

An analysis was made of the sites of infarction in our 400 patients. Fifty three percent of the patients had anterior, 27% inferior, 10% both anterior and inferior, 0.5% "true posterior", and 9% subendocardial infarction. In two patients, the exact site of infarction could not be determined (Table 2).

Continuous electrocardiographic monitoring of AMI pa tients have revealed that as many as 90% of patients suffer from some form of arrhythmias during the acute stage. Some of these arrhythmias such as infrequent ventricular extrasystoles are relatively benign whilst others like ventricular fibrillation are lethal. Hourly ECG strips were routinely recorded in our patients and also at any other time when the nurse observed an important arrhythmia. Excluding sinus brady and tachycardia and first degree heart block, 244 of our 400 patients (61%) exhibited some form of cardiac arrhythmias during their stay in the CCU. It has recently been pointed out that with the conventional method of monitoring and a rate-triggered alarm system such as was used in this series, a large percentage of cardiac arrhythemias,some of them potentially serious, will be missed. On-line arrhythmia computers have been developed to overcome this problem and are extremely accurate for the detection of cardiac arrhythmias (Vetter and Julian 1975). Sino-atrial block was seen in 2%, sinus arrest in 0.8%, supraventricular extrasystoles in 14% and accelerated junctional tachycardia in 1% of our patients (Table 3). In addition, 6% of the patients had atrial fibrillation and 4% atrial flutter. The incidence of these various arrhythmias is roughly similar to that observed by Jewitt et al (1967). Many of these supraventricular arrhythmias were transient whilst the majority of the remainder responded well to pharmacological therapy.

Of the ventricular arrhythmias, ventricular extrasystoles were the commonest, being seen in 35% of our patients. Extrasystolic ventricular tachycardia was encountered in 6%. Intravenous lignocaine (50 to 100 mgs as an initial bolus dose followed by continuous infusion of 2-3 mg/min) was our drug of choice for both frequent ventricular extrasystoles as well as extrasystolic ventricular tachycardia. In patients with extrasystolic ventricular tachycardia who did not respond to intravenous Lignocaine, synchronised electrocardioversion was performed. Our experience with ventricular fibrillation will be discussed in detail later. In accordance with the reports of others, we found accelerated idioventricular tachycardia a benign arrhythmia, nearly always in the background of a supraventricular bradyarrhythmia, and frequently needing no treatment at all (Rothfeld et al 1968).

The incidence of first degree heart block was 1%, second degree heart block 4%, complete heart block 8% and acute bundle branch block 9%. 29 or (7%) of our patients had an acute complete right bundle branch block and this was associated with either a left anterior or a left posterior hemiblock in 15 cases (51%). Sixteen out of these 29 patients, or 51%, died. Eight patients (2%) had acute complete left bundle branch block, with a mortality of 39%. Again, this experience is similar to those of other workers indicating that either acute right bundle branch block or acute left bundle

branch block in AMI is an ominous sign, as it is often associated with extensive anterior infarction, and frequently accompanied by severe pump failure. Thirty three or 8% of the patients had complete heart block. All the 15 pa tients with anterior infarction and complete heart block showed evidence of trifasicular block. Fourteen were paced and 6 died, giving a mortality rate of 40%. Many patients with complete heart block and acute anterior myocardial infarction will die despite pacing because of severe myocardial damage. However, there is little doubt that in a few of our patients with anterior myocardial infarction with minimal pump failure, but who presented with complete heart block and ventricular standstill, cardiac pacing was a life-saving procedure. The other 18 patients with complete heart block were associated with acute inferior infarction and 14 of these were paced. Six of these 14 patients had severe pump failure and died despite cardiac pacing giving a mortality rate of 33%. The remaining 4 patients were treated medically either because the complete heart block was transient, or because the general clinical condition of the patients was excellent and the ventricular rate adequate. All these 4 patients survived. In general, the prognosis of patients with complete heart block associated with inferior myocardial infarction is good. This is so because the extent of myocardial damage is usually small, and the ventricular rate is often adequate. Nevertheless, cardiac pacing may sometimes still be necessary if the ventricular rate is slow.

Twenty four or 6% of the 400 patients suffered from ventricular fibrillation (Table 5). This arrhythmia occured in 4 patients in the grade I class (the so-called "primary ventricular fibrillation"), in 11 patients in the grade II class, and in 9 patients in the grade III class. The mortality for ventricular fibrillation in our grade I patients was 0%, in our grade II patients was 18% and in our grade III patients was 89%. These results are similar to those reported by other workers (Bigger et al, 1977). The total mortality for all the ventricular fibrillation patients was 42%. It is gratifying to note that these results have improved considerably, compared to the 1967-1969 series, where the total mortality for all the ventricular fibrillation patients then was 78% and that for primary ventricular fibrillation was 50%. This improvement has been made possible chiefly because of the greater increase of experience of our doctors and particularly of our nurses, all of whom are now specially trained in coronary care work. Immediate electrical defibrillation is the single most important factor in salvaging patients with ventricular fibrillation. Since 1970, nurses in the CCU have been allowed to defibrillate patients with ventricular fibrillation on their own and this has shortened considerably the time interval between the onset of ventricular fibrillation to electrical defibrillation.

Mortality in the CCU is influenced by many factors — the age groups, the selectivity of the patients in terms of onset to monitoring time and most importantly the severity of the infarct. As to be expected, there is generally a progressive increase in mortality with increasing age, with the peak mortality occuring between 60-69 years in our 400 patients (table 6). As was pointed out earlier, the overall yearly mortality rate has remained fairly constant (around 16%) from 1969 onwards (Fig 2). However, if we were to compare the mortality rate during the two periods, 1967-1969 and 1975-1976, (Fig 8) taking into account infarct severity, it is obvious that the mortality rates for grade I and grade II cases have diminished significantly (from 3% to 0.5% in grade I cases and from 25% to 8% in grade II cases), whereas that for grade III patients has actually increased from 69% to 84%. The two deaths in our grade I patients in the 1975-1976 series occured as a result of sudden sinus arrest followed by asystole in one patient, and the sudden onset of slow idioventricular rhythm in the other. All the other grade III patients died predominantly of pump failure and were in either slow idioventricular rhythm or ventricular asystole at the time of death. The achievement with experience of an improvement in mortality in grade I and II AMI patients has also been reported by the Royal Melbourne Hospital group in Australia (Sloman et al 1976).

In conclusion, treatment of acute myocardial infarction in the CCU at the Singapore General Hospital has resulted in a significant lowering of mortality in grade I and grade II cases due primarily to better treatment of cardiac arrhthymias but not in patients with cardiogenic shock. The salvage of ischaemic myocardium and the continuing search for an effective treatment for severe pump failure remains the greatest challenge in the present and future management of AMI.

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