IMMEDIATE PROGNOSIS IN ACUTE MYOCARDIAL INFARCTION: SERIAL CHANGES IN IMMEDIATE MORTALITY RATE AND CAUSE OF DEATH

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In order to evaluate the effect of coronary care on the immediate mortality rate of acute myocardial infarction and to clarify the problems in coronary care, we attempted to investigate the immediate mortality rate and causes of deaths in 492 patients with acute myocardial infarction who had admitted to the hospital within 24 hours after the onset of infarct from January, 1972 to December, 1981. Three hundred and seventy-nine were men and 113 were women, and their mean age was 61.8 years ranging from 28 to 91 years. One hundred and twenty-seven patients had a previous history of myocardial infarction and 365 patients had none. One hundred and ninety patients of these 365 patients without a previous infarction had anterior infarction, 152 patients inferior infarction and 23 patients subendocardial infarction. All patients were subdivided into four stages according to the time of the onset of infarct: Stage 1 (29 patients); 1972–1975, Stage 2 (101 patients); 1976–1977, Stage 3 (148 patients); 1978–1979 and Stage 4 (214 patients); 1980–1981.

No significant differences in age, sex and infarct site among the four periods were found. Time interval between the onset of infarct and admission shortened serially and the ratio of reinfarction to initial infarction increased. Immediate mortality rate (within four weeks after the onset of infarct) was 20.5% in all patients. Immediate mortality rate in Stage 1 was 24.1%, 26.7% in Stage 2, 23.0% in Stage 3 and 15.4% in Stage 4, respectively. Thus, this finding indicates that the immediate prognosis in patients with acute myocardial infarction who admitted to the hospital in recent two years improved markedly. Immediate prognosis in elderly patients was worse than that in younger patients. However, serial improvement in the immediate prognosis in elderly patients was observed. Similarly, immediate mortality rate in patients complicated with a large infarct or congestive heart failure was higher than that in those without a large infarct and no congestive heart failure. Although the immediate prognosis in patients with previous infarction was worse than that in those without previous infarction, the immediate prognosis in patients with previous infarction improved serially. Pump failure was the most common cause of death, accounting 55.4% of all deaths. The incidence of cardiac rupture was 20.8% of all deaths, arrhythmias 13.9% and other causes 9.9%, respectively. Serial analysis of cause of death indicates that the incidence of pump failure and arrhythmia reduced sharply. This reduction in mortality rate may be due to improved management in our CCU.

Key Words:

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TABLE I CLINICAL CHARACTERISTICS OF THE PATIENTS POPULATION OF FOUR STAGES

No. of Patients

Stage	Age (yrs.)	Sex		Infarct Site			Re	Killip				Mortality Rate (%)
		M	F	A	I	S		I	II	III	IV	
1 29	61.4 ± 2.1	22	7	10	13	1	5	16	8	2	3	24.1
2 101	61.2 ± 1.6	79	22	47	30	6	18	59	16	13	13	26.7
3 148	62.8 ± 1.2	117	31	52	44	8	44	102	24	14	8	23.0
4 214	61.6 ± 1.0	161	53	81	65	8	60	153	36	19	6	15.4

Abbreviations: M = Male, F = Female, A = Anterior, I = Inferior, S = Subendocardial, Re = Reinfarction, Killip = Killip's Classification
mean ± SE

IN spite of introduction of CCU system, immediate mortality rate has been still high¹⁻³ and the reduction in mortality rate has been strongly expected. In order to improve the immediate prognosis in acute myocardial infarction, it is necessary to evaluate the immediate mortality rate and cause of death serially and to plan the proper treatment in coronary care unit. Although many reports concerning the immediate prognosis in acute myocardial infarction were found in the literatures,¹⁻³ for evaluation of immediate prognosis in acute myocardial infarction the following points should be considered: 1) time interval between the onset of infarct and admission, 2) factors affecting the immediate prognosis such as age, sex, previous history of myocardial infarction, infarct size and site and 3) management in coronary care unit. Therefore, we attempted to evaluate the immediate mortality rate and cause of deaths serially and to analyze the problems in the treatment of acute myocardial infarction in this study.

MATERIALS AND METHODS

Four hundred and ninety-two patients who admitted to the hospital within 24 hours after the onset of myocardial infarction from January 1972 to December 1981, were studied. Three hundred and seventy-nine were men and 113 were women, and their mean age was 61.8 years, ranging from 28 to 91 years. Three hundred and sixty-five patients had not a previous myocardial infarction and 127 patients had a history of previous infarction. One hundred and ninety of 365 patients without previous infarction had anterior infarction, 152 patients inferior infarction and the remaining 23 patients subendocardial infarction.

Diagnosis of myocardial infarction was done on the basis of the typical chest pain, characteristic ST change and/or Q wave and elevation of serum levels of cardiac enzymes. Infarct size was expressed as a total released CPK (Σ CPK) calculated from serial CPK activities using Sobel's method.⁴ We evaluated the immediate mortality within 4 weeks after onset of infarct and cause of death in all patients. Serial changes in the immediate mortality rate and cause of death were also evaluated. For statistical analysis, Student's *t* test was used to assess the differences between means of independent observations. The chi-square test was also used to assess the differences in proportions. The threshold of significance was $p < 0.05$.

RESULTS

For the estimation of serial changes in the immediate mortality rate and cause of death, all patients were subdivided into four subgroups according to the time of admission as follows: Stage 1 (29 patients) 1972-1975, Stage 2 (101 patients) 1976-1977, Stage 3 (148 patients) 1978-1979 and Stage 4 (214 patients) 1980-1981.

Clinical Characteristics of Population of Four Stages

Table I shows mean age, sex, previous myocardial infarction, infarct site, Killip's classification⁵ on admission and the immediate mortality rate in four periods. Mean time interval between the onset of infarct and admission to the hospital was 7.6 hours. Mean time of admission delay in Stages 3 and 4 was 4.6 ± 0.4 (SE) hours and significantly shorter than that in Stages 1 and 2

Fig. 1. Relation of age to the immediate mortality.
Group A: ≥ 65 years, Group B: 50–64 years, Group C: < 50 years

(17.8 ± 1.2 hours, $p < 0.001$). No significant differences in mean age and sex ratio among four stages were found. The incidence of reinfarction increased serially. No significant difference in distribution of infarct site in patients without previous myocardial infarction among four stages was also observed. Furthermore, no significant difference in distribution of Killip's classification on admission among four stages was found.

Serial Changes in the Immediate Mortality Rate

One hundred and one of the 492 patients with acute myocardial infarction died within 4 weeks after the onset of infarct and the immediate mortality rate in all patients was 20.5%. The immediate mortality rate was 24.1% in Stage 1, 26.7% in Stage 2, 23.0% in Stage 3 and 15.4% in Stage 4. Thus, the immediate mortality rate in recent two years markedly reduced.

Factors Affecting the Immediate Prognosis

1. Age

All patients were subdivided into three groups as follows: Group A (218 patients); ≥ 65 years, Group B (207 patients); 50–64 years, Group C (67 patients); < 50 years. The immediate mortality rate in Group A was 28.4%, 16.9%, in Group B and 6.1% in Group C in all stages. Thus, the immediate prognosis in Group A was significantly worse than those in Groups B ($p < 0.01$) and C ($p < 0.001$). With respect to serial changes in the immediate mortality rate in Group A, the immediate mortality rate in Stage 1 was 38.5%,

Fig. 2. Relation of previous history of myocardial infarction to the immediate mortality

43.5% in Stage 2, 30.4% in Stage 3 and 21.1% in Stage 4 (Fig. 1). Thus, the immediate prognosis in Group A improved serially. On the other hand, the immediate mortality rates in Groups B and C were low throughout the period and serial improvement in the immediate prognosis was not observed.

2. Previous Myocardial Infarction

While 64 of 365 patients (17.5%) without previous myocardial infarction died within 4 weeks after the onset of infarct in all stages, the immediate mortality rate in 127 patients with previous myocardial infarction was 29.1%. Thus, the immediate mortality rate in reinfarction was significantly higher than that in first infarction ($p < 0.01$). In 365 patients with first infarction, the immediate mortality rate was 16.7% in Stage 1, 20.5% in Stage 2 19.6% in Stage 3 and 16.1% in Stage 4 and no significant reduction in the immediate mortality rate was observed (Fig. 2). On the other hand, in 127 patients with reinfarction the immediate prognosis dramatically improved serially (Stage 1 60.0%, Stage 2 55.6, Stage 3 31.7%, Stage 4 13.4%).

3. Infarct Site

While the immediate mortality rate in 190 patients with anterior infarction was 21.6% and that in 152 patients with inferior infarction was 14.4% in all stages. Thus, no significant difference

Fig. 3. Relation of infarct site to the immediate mortality in patients without previous myocardial infarction.

Fig. 4. Relation of infarct size to the immediate mortality. Group S: Σ CPK < 1000 IU/l, Group M: Σ CPK 1000–2000 IU/l, Group L: Σ CPK > 2000 IU/l

in mortality rate between in patients with anterior infarction and in those with inferior infarction in all stages. In 190 patients with anterior infarction, the immediate mortality rate in Stage 1 was 30.0%, 23.4% in Stage 2, 20.8% in Stage 3 and 20.0% in

Fig. 5. Relation of severity of congestive heart failure (Killip's classification) to the immediate mortality. K-I: Killip I, K-II: Killip II, K-III: Killip III, K-IV: Killip IV

Stage 4, respectively and the immediate mortality rate reduced serially (Fig. 3). In 152 patients with inferior infarction, the immediate mortality rate in Stage 1 was 4.2%, 16.7% in Stage 2, 21.7% in Stage 3 and 9.4% in Stage 4, respectively. Except in Stage 1, no significant differences in mortality rate between in anterior infarction and inferior infarction were observed.

4. Infarct Size

In order to evaluate the relation of infarct size to the immediate mortality rate, we estimated the cumulative CPK released (Σ CPK) from CPK activities as an index of infarct size in 232 patients with first infarction. Patients were subdivided into three groups according to the values of Σ CPK: Group S (116 patients); Σ CPK less than 1000 IU/l, Group M (85 patients); Σ CPK 1000–2000 IU/l, Group L (23 patients); Σ CPK more than 2000 IU/l. The immediate mortality rate in Group S was 6.3% and no significant differences in mortality rate among four stages were found (Fig. 4). On the other hand, 11 of 22 patients (50.0%) in Group L died during four weeks follow-up. Thus, this finding indicates that infarct size is one of the major contributing factors to immediate prognosis. Contrary to Group S, the immediate mortality rate in Group L reduced serially.

Fig. 6. Cause of death in each stage.

5. Congestive Heart Failure

For evaluation of the relation of congestive heart failure to the immediate prognosis, we subdivided all patients into four groups according to Killip's classification⁵. The immediate mortality rate in Killip I (K-I) was 10.4%, 34.6% in Killip II (K-II), 41.7% in Killip III (K-III) and 71.0% in Killip IV (K-IV), respectively. Thus, the immediate prognosis in patients complicating congestive heart failure was worse than that in patients without congestive heart failure. With respect to serial changes in prognosis, while no significant improvement of prognosis in Killip I and II was observed, the immediate mortality rate in Killip III dramatically reduced serially (Fig. 5).

Cause of Death

Fifty-six of all deaths (55.4%) within four weeks after the onset of infarct was pump failure, 21 (20.8%) cardiac rupture, 14 (13.9%) arrhythmia and 10 (9.9%) other causes. The incidence of deaths from pump failure at Stage 1 was 17.2% of all patients and reduced serially (Stage 2 15.8%, Stage 3 12.2%, Stage 4 7.9%) (Fig. 6). Mortality rate caused by arrhythmia was 3.4% in Stage 1, 6.2% in Stage 2, 2.7% in Stage 3 and 1.4% in Stage 4. The incidence of cardiac rupture were 3.4% in Stage 1, 3.0% in Stage 2, 6.1% in Stage 3 and 3.7% in Stage 4. Other causes of deaths were respiratory failure, embolism, sudden death and non-cardiac deaths and the incidence of other causes increased serially (Stage 1 0.0%, Stage 2 2.0%, Stage 3 2.0% and Stage 4 2.3%).

DISCUSSION

It is important to evaluate the immediate prognosis and cause of death and to clarify the problems in the treatment in early phase of acute myocardial infarction. Although many investigators reported the immediate prognosis in acute myocardial infarction^{1, 2, 3}, only few reports concerning serial changes in the immediate mortality rate and cause of death were in the literatures^{6, 7, 8}. Therefore, we evaluated the immediate prognosis in acute myocardial infarction and serial changes in the immediate prognosis in this study.

Immediate Mortality Rate in Acute Myocardial Infarction

In our series, the immediate mortality rate in all patients was 20.5%. The immediate prognosis in patients with old age, reinfarction, large infarct or congestive heart failure was poor. In regard to the immediate mortality rate in acute myocardial infarction, many investigators reported that the immediate mortality rate were 13–30%^{1, 2, 3}, and the introduction and development of CCU have improved the immediate prognosis in acute myocardial infarction. In our study, the mortality rate in Stage 1 was 24.1%, 26.7% in Stage 2, 23.0% in Stage 3 and 15.4% in Stage 4 (Table I). Thus, the immediate mortality rate in recent two years significantly reduced. Weinberg investigated the immediate mortality rate in 1361 patients with acute myocardial infarction. He reported that no significant differences in the immediate mortality rate in former 5 years and in latter 3 years (former 5 years: 17%, latter 3 years 17%)⁶. On the other hand, Sekiguchi et al evaluated the immediate mortality rate in 864 patients with acute myocardial infarction from 1969 to 1977⁸. They subdivided these patients into three groups according to time of the onset of infarct: Group I (263 patients); 1969–1972, Group II (254 patients); 1973–1976, Group III (83 patients); 1977. They reported that the immediate mortality rate in Group I was 26.6%, 22.4% in Group II and 19.3% in Group III and the immediate prognosis improved serially. Hunt et al also observed serial improvement in the immediate prognosis in acute myocardial infarction⁷. These results were in agreement with our data. In our series, we observed serial improvement in the immediate mortality rate in patients with old age, reinfarction or congestive heart failure (Fig. 1, 2, 5). The immediate prognosis in elderly patients

with acute myocardial infarction has been worse than that in younger patients^{9, 10}. The reasons of high mortality rate were considered as follows: 1) decrease in contractility of non-infarcted residual myocardium, 2) high incidence of complication of pump failure due to severe coronary artery lesion and 3) high incidence of complication of multiple organ failure following acute myocardial infarction.¹¹ The improvement in the immediate prognosis in elderly patients with acute myocardial infarction may be attributed to progress in drug therapy for arrhythmias and pump failure,¹² the introduction and development of surgical therapy such as intraaortic balloon pumping (IABP) and coronary artery bypass grafting (CABG)¹³ and the development of treatment of multiple organ failure i.e. acute renal failure, pneumonia. On the other hand, no significant improvement in the immediate prognosis in younger patients was observed. One of reasons of this finding may be that the immediate mortality rate in younger patients was very low. Another reason may be that patients who died had broad infarction and often complicated with cardiogenic shock and/or severe intractable congestive heart failure.

Although many investigators reported that patients with previous myocardial infarction were more commonly complicated with congestive heart failure than those without previous myocardial infarction and the immediate mortality rate in patients with previous infarction was higher than that in those without previous infarction,^{14, 15} the immediate prognosis in patients with previous myocardial infarction improved dramatically in this study (Fig. 2). One of reasons of the serial improvement in the immediate prognosis is attributed to the progress in therapy for pump failure as above mentioned. Another reason is the differences in pathogenesis of congestive heart failure between in first infarction and in reinfarction. Fukui et al investigated the incidence of heart failure, response to therapy and the immediate prognosis in 216 patients with acute myocardial infarction.¹⁶ They reported that patients with previous infarction were more commonly complicated with congestive heart failure than those without previous infarction but congestive heart failure in patients with previous infarction more responded to conventional drug therapy such as diuretics and/or vasodilators than that in those without previous infarction. Furthermore, the immediate prognosis in patients with previous infarction

complicating congestive heart failure was better than that in those without previous infarction.

The immediate prognosis in patients with complicating severe heart failure (Killip III, IV) improved serially and this finding may also attributed the progress in the treatment of pump failure (Fig. 5).

Cause of Death

Deaths caused by pump failure in Stage 1 was 17.2% and mortality rate of pump failure reduced serially (Fig. 6). Reduction in mortality rate of pump failure is attributed to the progress in treatment of pump failure. The incidence of arrhythmia as cause of death reduced sharply. The reason of this finding is considered the progress in monitoring system for arrhythmia in CCU, the introduction of new antiarrhythmic agents, transvenous pacing and defibrillation.¹⁷ Because of reduction of death by pump failure and arrhythmia, cardiac rupture has become an important cause of death in CCU. In our series, the incidence of cardiac rupture was low in Stage 1 and in Stage 2 and increased in Stage 3 and decreased in Stage 4. Cardiac rupture more commonly occurred immediately after the onset of myocardial infarction.^{18, 19} One of the reasons of low incidence of cardiac rupture in Stage 1 is that the time interval between the onset of infarct and admission was long. The high incidence of cardiac rupture in Stage 3 is attributed to shortening time from the onset of infarct and admission and to the development of diagnosis of cardiac rupture. Thereafter, the therapy for chest pain and/or control of systemic blood pressure which is considered one of the factors contributing to occurrence of cardiac rupture reduced the incidence of cardiac rupture. In our series, other causes of death increased serially. These included acute renal failure and pneumonia following severe congestive heart failure. Further investigations are needed for proper therapy for these complications.

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