Declining Trend in the In-Hospital Case-Fatality Rate From Acute Myocardial Infarction in Miyagi Prefecture From 1980 to 1999

Jun Watanabe, MD; Kaoru Iwabuchi, MD; Yoshito Koseki, MD; Mitsumasa Fukuchi, MD; Tsuyoshi Shinozaki, MD; Masahito Miura, MD; Tatsuya Komaru, MD; Yutaka Kagaya, MD; Kunio Shirato, MD; Shigenori Kitaoka, MD; Nobumasa Ishide, MD; Tamotsu Takishima, MD

The case-fatality rate from acute myocardial infarction (AMI) appears to have been declining in recent decades, so the present study reviewed the trend in in-hospital case-fatalities from AMI in Miyagi Prefecture, Japan, 1980–1999. The causes of death and the effects of gender and age on the trend were also analyzed. From the AMI registration database of the Miyagi Study Group for AMI, 12,961 cases of AMI were analyzed. The 30-day in-hospital case-fatality was calculated from the data for 1980–1999: data for causes of death were available for 1980–1997, and the data concerning primary percutaneous transluminal coronary angioplasty (PTCA) for AMI were available for 1997–1999. The in-hospital case-fatality rate declined from 17.0% in the early 80s to 7.3% in the late 90s (approximately 57% reduction). The in-hospital case-fatality rate was higher in female patients. Rhythm failure substantially decreased in the late 1980s. Pump failure is decreasing, but is still the biggest problem. The in-hospital case-fatality rate was significantly lower in patients received PTCA. The declining trend in the in-hospital case-fatality rate suggests the benefits of current therapeutic procedures, including primary PTCA, for AMI. Pump failure is an important target for further decreasing the trend. (Jpn Circ J 2001; 65: 941–946)

Key Words: Miyagi, Japan; Percutaneous transluminal coronary angioplasty (PTCA); Pump failure; Registration study

The case-fatality rate from acute myocardial infarction (AMI) has reportedly been declining in recent decades, probably because new therapeutic procedures for preventing complications and reducing the infarction area have become established in most industrialized countries. Such procedures include adequate medication and monitoring in the coronary care unit (CCU), thrombolytic therapy by the venous or coronary approach and percutaneous transluminal coronary angioplasty (PTCA).

The first object of the present study was to confirm the declining trend in the case-fatality rate of AMI using an epidemiological registration study in Miyagi Prefecture, Japan, that has continued since 1980 on a population-wide basis. Second, we considered the effects of gender and age on the in-hospital case-fatality rate, third, the causes of death were analyzed and fourth, the impact of new treatments, in particular, the influence of primary PTCA on the case-fatality rate was evaluated. Ueshima et al reported that mortality from ischemic heart disease had been decreasing in Japan from 1956 to 1980, and the present study may provide additional valuable data concerning the in-hospital case-fatality from AMI from 1980 to 1999, because treatment strategies have dramatically changed over the recent decades.

Methods

Source of AMI Data

The AMI registration database of the Miyagi Study Group of AMI was used. This registration study was a prospective, multicenter, observational study preliminarily started from 1979 and data from the approximately 13,000 AMI cases registered from 1980 to 1999 were available. All large hospitals with CCU and catheterization facilities in Miyagi Prefecture participated (see appendix) and the Study Group Office collected the AMI registration forms and published an annual report.

The diagnosis of AMI was made by individual cardiologists according to the contemporary standard. Generally, it was based on typical symptoms, ECG changes, and increased serum cardiac enzymes (ie, creatine kinase, aspartate aminotransferase, and lactate dehydrogenase). More recently, diagnostic coronary angiography was frequently performed.

Data Analysis

Some cases were excluded because personal data (age and gender) were incomplete, and death-on-arrival cases were also excluded. Consequently, 12,961 AMI cases were analyzed. The in-hospital case-fatality rate within 30 days of admission was calculated, taking only cardiac death into account.

The causes of cardiac death were simply categorized into pump failure, rhythm failure and cardiac rupture. Pump failure included cardiogenic shock and congestive heart failure. Rhythm failure included fatal ventricular arrhythmia and sudden death, as well as rhythm failure-induced sudden cardiac death in the patients with congestive heart failure and unexpected sudden deaths, unless another cause of death was evident. Ventricular rupture was diagnosed primarily by echocardiography.

Effects of PTCA on the In-Hospital Case-Fatality Rate

We were particularly interested to ascertain whether PTCA had actually improved the in-hospital case-fatality rate. Data concerning PTCA outcomes were available for 1997–1999 (2,604 cases) and initially we simply compared the in-hospital case-fatality rate in those 3 years between the patients who underwent PTCA and those who did not. Second, we compared the case-fatality rate of the PTCA and non-PTCA patients in 1997–1999 with that of patients registered in 1985–1990 (non-PTCA era). Third, the trend in the case-fatality rate in the hospitals where PTCA could be performed 24 hours a day in the past 5 years (1995–1999) was compared with that in the other hospitals (PTCA-capable hospitals and hospitals that were not).

Statistics

The difference in the case-fatality rate was statistically estimated by the \( \chi^2 \)-test using the numbers of deaths and survivals. Age and gender differences were also estimated using the \( \chi^2 \)-test.

Results

Declining Trend in the In-Hospital Case-Fatality Rate for AMI

The in-hospital case-fatality rate of 12,961 AMI cases (from 1980 to 1999) was analyzed and Fig 1 shows the trends in the number of AMI cases registered and the in-hospital case-fatality rate. In the early 1980s, the case-fatality rate was around 15% and progressively decreased to around 7% in the late 1990s. The number of AMI cases registered appeared to reach a plateau in the late 1990s. The population of Miyagi Prefecture was 2,364,634 in 1999

![Fig 1. Trends in the number and crude case-fatality rate (≤30 days) for AMI in Miyagi Prefecture, 1980–1999. The number of registrations (A) was increasing and reached a plateau (37.5/100,000 population) in the late 1990s. Note that the registered number underestimates the total developed number of AMI cases. The trend in the in-hospital case-fatality rate (B) continued to decline over these decades.](image)

![Fig 2. Crude in-hospital case-fatality rate by 5-year periods. The rate decreased from 17% in early 1980 to 7.3% in the late 1990s. The decline was statistically significant (\( \chi^2 = 158.7, p < 0.001 \)).](image)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Male patients</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;50 (%)</td>
<td>12.8</td>
<td>12.7</td>
<td>11.4</td>
<td>12.2</td>
</tr>
<tr>
<td>51–60 (%)</td>
<td>28.0</td>
<td>26.6</td>
<td>20.3</td>
<td>19.0</td>
</tr>
<tr>
<td>61–70 (%)</td>
<td>30.6</td>
<td>29.8</td>
<td>33.6</td>
<td>30.1</td>
</tr>
<tr>
<td>71–80 (%)</td>
<td>23.8</td>
<td>23.4</td>
<td>25.1</td>
<td>25.9</td>
</tr>
<tr>
<td>80+ (%)</td>
<td>4.8</td>
<td>7.5</td>
<td>9.6</td>
<td>12.8</td>
</tr>
<tr>
<td>No. of cases</td>
<td>1,283</td>
<td>2,096</td>
<td>2,607</td>
<td>3,393</td>
</tr>
<tr>
<td>Female patients</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;50 (%)</td>
<td>4.3</td>
<td>7.0</td>
<td>2.7</td>
<td>2.6</td>
</tr>
<tr>
<td>51–60 (%)</td>
<td>11.4</td>
<td>15.3</td>
<td>8.5</td>
<td>6.1</td>
</tr>
<tr>
<td>61–70 (%)</td>
<td>31.1</td>
<td>32.3</td>
<td>26.7</td>
<td>21.2</td>
</tr>
<tr>
<td>71–80 (%)</td>
<td>40.4</td>
<td>32.1</td>
<td>37.5</td>
<td>39.2</td>
</tr>
<tr>
<td>80+ (%)</td>
<td>12.8</td>
<td>13.3</td>
<td>24.6</td>
<td>30.8</td>
</tr>
<tr>
<td>No. of cases</td>
<td>474</td>
<td>775</td>
<td>1,014</td>
<td>1,319</td>
</tr>
</tbody>
</table>
and the normalized number of AMI cases was approximately 37.5/100,000 population at that time. Note that the registered number more or less underestimates the total developed number of AMI cases.

Fig 2 shows the in-hospital case-fatality rate in 1980–1984, 1985–1989, 1990–1994, and 1995–1999. The \(\chi^2\)-test was significant (\(p<0.001\)) and the case-fatality rate decreased from 17.0 to 7.3\% (by 57\%). Significant decrease in the case-fatality rate was observed in 1990–1999.

Table 1 shows the distribution of registered AMI cases by age and gender, and the trend in the in-hospital case-fatality rates for each age class and gender is shown in Fig 3. The case-fatality rate appeared to decrease in both genders and all age classes, although it was still higher than 10\% in elderly patients (male patients >80, female patients >70 years old). From 1995 to 1999, there were 204 deaths out of 3,156 male AMI patients and 142 deaths out of 1,229 female AMI patients (\(\chi^2=31.5, p<0.01\)). A significant difference was found in the patients aged 70–79 years.

Fig 4 summarizes the causes of death from the data available for 1980–1996. Of the causes of cardiac death within 30 days of admission (Fig 4A), rhythm failure greatly decreased in 1985–1988 and was less than 10/1,000 AMI cases in 1993–1996. Pump failure also appeared to decrease progressively, but was still higher at 55/1,000 AMI cases. Cardiac rupture appeared to remain constant at 10–20/1,000 AMI cases. The trends in the case-fatality rate within 48 h were nearly identical to those within 30 days of admission (Fig 4B). For the time period between 48 h and 30 days, pump failure remained at a plateau of around 30/1,000 AMI cases in 1989–1996.

**Fig 3.** Age- (A, B) and gender-differences (C) in the case-fatality rate. The rate was higher in elderly patients, particularly female patients aged 70–79 compared with male patients in the same age class.

**Fig 4.** Causes of acute death (A, \(\leq 30\) days) in AMI: pump failure (cardiogenic shock and congestive heart failure), rhythm failure (fatal arrhythmias), and cardiac rupture. The trend in pump failure death within 48 h has continued to decline (B), but still remains at high level. In particular, pump failure death in the time period 48 h to 30 days post onset reached a plateau in the last decade (C).

**Fig 5.** In-hospital case-fatality rate for patients who did or did not undergo PTCA during 1997–1999. The rate was around 3.5\% for patients who were admitted within 24 h and underwent PTCA.

**Fig 6.** In-hospital case-fatality rate in 1997–1999 in the patients admitted within 24 h of the onset was around 3.5\% for patients who underwent primary PTCA, significantly less than in patients who were not treated with primary PTCA (around 12\%). The in-hospital case-fatality rate in the patients who did not undergo primary PTCA was nearly identical to the crude in-hospital case-fatality rate of AMI patient in 1985–1990. At that time, primary PTCA for AMI was seldom done. Fig 7 summa-
rizes the in-hospital case-fatality rate of the subgroups classified by gender and age. The patients who received primary PTCA demonstrated a significantly lower in-hospital case-fatality rate except for female patients aged >70 years. Note that PTCA was performed according to the individual cardiologist’s decision, not by randomized design.

Fig 8 shows the in-hospital case-fatality rates in the PTCA-capable hospitals and those that were not. No significant difference in the in-hospital case-fatality rate except for female patients aged >70 years. Note that PTCA was performed according to the individual cardiologist’s decision, not by randomized design.

Fig 8 shows the in-hospital case-fatality rates in the PTCA-capable hospitals and those that were not. No significant difference in the in-hospital case-fatality rate was observed between these hospitals in the 1980s, and although the inhospital case-fatality rate progressively improved to around 7% in the PTCA-capable hospitals, it reached a plateau at around 17% in other hospitals. The in-hospital case-fatality rate decreased in both genders. In the most recent 5 years (1995–1999), the in-hospital case-fatality rate was significantly worse in female patients than in male patients, particularly those aged more than 70 (probably because the number of cases was insufficient).

Fig 9 summarizes the previous reports from Western countries concerning in-hospital case-fatality rates (within 28 or 30 days) from the onset of AMI. The in-hospital case-fatality rate was 14–21% in the early 1980s, 12–23% in the late 1980s, 7.4–18% in the early 1990s, and 8–12% in the late 1990s. In 1995–1999, AMI patients who underwent PTCA had relatively low in-hospital case-fatality rates (3.5–5.8%). The in-hospital case-fatality rate in the present study was superimposed on these declining trends, indicating that the decrease in the in-hospital case-fatality rates common in those countries was also occurring in Japan.

From our 20-year observation, the in-hospital case-fatality rate significantly decreased, but we must take into account the selection bias of the patients because the number of registered patients was less in the 1980s than in 1990s. Therefore, the higher rate of in-hospital case-fatality in the 1980s may be explained, at least partially, by the selection bias that relatively severe patients were transferred to the study-group hospitals where trained cardiologists and CCU facilities were available. However, we believe that this selection bias may not be a major factor affecting the higher case-fatality rate in 1980s, because the rate is not higher than other contemporary data, rather, it is nearly identical to those of other reports from various countries (Fig 9).

The in-hospital case-fatality rate decreased in both genders. In the most recent 5 years (1995–1999), the in-hospital case-fatality rate was significantly worse in female patients than in male patients, particularly those aged more than 70 years.

Discussion

Declining Trend of the In-Hospital Case-Fatality Rate for AMI

In Miyagi Prefecture, Japan, the in-hospital case-fatality rate decreased from 17.0% in the early 1980s to 13.1% in the late 1980s, to 9.1% in the early 1990s and to 7.3% in the late 1990s. The decrease in the case-fatality rate appeared to occur in both genders and in all age classes.

Fig 9 summarizes the previous reports from Western
70–79 years. Some investigators have reported that the in-hospital case-fatality rate was higher for female patients; but Rosengren reported that female patients aged 75 years or more had a better prognosis in terms of the 28-day case fatality rate! A number of investigators reported that female patients receive somewhat less aggressive treatment during the early stage of hospitalization and have higher in-hospital mortality. In the present study, PTCA was performed equally in female and male patients aged 70–79 (63 vs 65%, NS) and there was no significant difference in prehospital delay from symptoms to hospitalization; 78% of female and 81% of male patients were hospitalized within 24 h, and 68% of female and 70% of male patients were hospitalized within 12 h. Although the exact causes remain unclear, less aggressive treatment and the prehospital duration are not likely explanations of the higher in-hospital case-fatality rate in female patients aged 70–79 and further investigation concerning the gender difference is required.

The causes of death clearly changed in the 1980s. Deaths from rhythm failure markedly decreased in this period and although the number of the pump failure deaths continued to decrease, it was still the biggest problem in 1993–1996. Approximately, 46% of the pump failure deaths occurred within 48 h.

**Outcome of PTCA on the In-Hospital Case-Fatality Rate**

First, we observed that the in-hospital case-fatality rate was significantly lower in patients who underwent PTCA (Fig 5). Second, the trend of the in-hospital case-fatality rate in PTCA-capable hospitals has continued to decrease in the 1990s (PTCA era), but it has remained higher in hospitals that are not PTCA-capable (Fig 8). The in-hospital case-fatality rate of patients who did not receive PTCA in 1997–1999 was nearly identical with that of patients in the 1980s (non-PTCA era). The lowering of the rate was observed in both genders and in elderly patients (Fig 7) and the data strongly suggest that PTCA has actually reduced the in-hospital case-fatalities in the last decade, although we need to carefully interpret the present data, mainly because they are from an observational, not a randomized, study. There may be some selection bias between the patients who underwent PTCA and those who did not. For example, it is possible that the patients did not undergo PTCA because of severely depressed hemodynamics, but it is unlikely that this kind of selection bias can fully explain the advantage of primary PTCA in the present data. First, the in-hospital case-fatality rate of the patients who did not undergo PTCA in 1995–1999 was nearly identical to the crude in-hospital case-fatality rate in the late 1980s (non-PTCA era). Second, the in-hospital case-fatality rate substantially improved in the PTCA-capable hospitals, whereas there was not a significant difference in 1980 (Fig 8). Third, the difference in the in-hospital case-fatality rate was insignificant between patients who underwent primary PTCA and those who did not, if they were admitted or transferred 24 h or more after symptom onset. Many investigators have reported the advantages of current therapies, including primary PTCA, and the in-hospital case-fatality rate of the present study was consistent with those reports (Fig 9).

In summary, the in-hospital case-fatality rate declined by approximately 57% in 1980–1999. Female AMI patients had a higher in-hospital case-fatality rate, which was remarkable in the patients aged 70–79 years. The in-hospital case-fatality rate was still higher than 10% in elderly patients. The cause of death also changed; that is, rhythm failure greatly decreased in 1985–1988 and now, pump failure is the most frequent cause of in-hospital death for AMI within 30 days. The in-hospital case-fatality rate was significantly lower in patients who underwent PTCA, but we cannot exclude the selection bias that AMI patients who did not undergo primary PTCA because of the severity of disease and/or other disadvantages, such as age, complications and the patient’s understanding of the procedure. However, randomized trials for primary PTCA cannot be performed because of ethical problems, so historical comparison is the second best way to evaluate the current therapies. Also, because we did not survey medications before and after the development of AMI, their effects on the outcome could not be assessed in this study. Another limitation of the study is that because of the study design we did not assess the long-term survival.

In conclusion, the present data suggest that the current treatments for AMI, including primary PTCA, have improved the in-hospital case-fatality rate. Pump failure (cardiogenic shock and heart failure) is the most important target for increasing the survival of AMI patients in the present time, and the relatively high case-fatality rate in female patients aged over 70 years should be further investigated.

**Acknowledgments**

This study was supported by agencies of Sendai city and Miyagi prefecture, and Sendai and Miyagi medical associations also supported this study. We thank Bayer Yakuhin Ltd very much for their cooperation with the study. We also thank Ms Hiroko Miura and Mr Brent Bell for their assistance with the manuscript.

**References**


Appendix

Hospital List (Alphabetical Order)

Fukaya Hospital; Furukawa City Hospital; Hikarigaoka Spellman Hospital; Ishinomaki Municipal Hospital; Ishinomaki Red-cross Hospital; JR Sendai Hospital; Katta Hospital; Kesen-numa Hospital; Labour Welfare Corporation Tohoku Rosai Hospital; Marumori National Health Insurance Hospital; MIYAGI Cancer Center; Mori Hospital; Nagamachi Hospital; Nishitaga National Hospital; NTT EAST Tohoku Hospital; Ohgawara Municipal Hospital; Ohoizumi Memorial Hospital; Saito Hospital; Saka General Hospital; Sanuma General Hospital; Semine Prefectural Hospital; Sendai Cardiovascular Center; Sendai City Hospital; Sendai Kosei Hospital; Sendai National Hospital; Sendai Open Hospital; Sendai City Medical Center; Sendai Public Health Insurance Hospital; Sendai Red-cross Hospital; Sendai Tokushukai Hospital; Sen’en General Hospital; Shichigashuku National Health Insurance Clinic; Siogama City Hospital; Tohoku Koso Hospital; Tohoku University Hospital; Tohoku Welfare Pension Hospital; Tome Public Hospital; Tsukidate Public Hospital.