Temporal Trends in Hospitalization for Acute Myocardial Infarction Between 2004 and 2011 in Kumamoto, Japan

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**Background:** The Kumamoto Acute Coronary Events Study explored trends for acute myocardial infarction (AMI).

**Methods and Results:** The number of people of advanced age in Kumamoto Prefecture has gradually increased. In 2004–2011, 8,131 AMI patients were registered. Although the age-adjusted AMI incidence in men decreased from 93.1 in 2004 to 70.7 in 2011 (P=0.0294), the age-adjusted in-hospital cardiac death rate was maintained at ~7%; however, the all-cause mortality and noncardiac death rate increased and appeared to be related.

**Conclusions:** A steady trend of decreasing AMI incidence was observed. Urgent measures should be established against non-cardiac mortality in this era of an aging population.  

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**Key Words:** Acute myocardial infarction; Aging; Kumamoto Acute Coronary Events Study; Noncardiac death

The incidence of acute myocardial infarction (AMI) in Japan increased until 2000, in contrast to the USA, where it has decreased since before 2000. Currently, there is no national registry data related to AMI in Japan, on a municipal or prefectural level. Because the current data is limited to that of some participating institutions, the accurate incidence of AMI in Japan remains unknown.

We established the Kumamoto Acute Coronary Events (KACE) study group to examine the accurate incidence of AMI in the Kumamoto Prefecture by registering all cases and studying recent trends.

**Methods**

The KACE study is a prospective, multicenter, observational study, with 20 participating institutions in the Kumamoto Prefecture capable of performing coronary angiography and coronary intervention. Most of the patients with onset of AMI were transported to 1 of the 20 participating institutions. This study was approved by the Epidemiology and General Research Ethics Committee of the Faculty of Life Sciences at Kumamoto University.

AMI was diagnosed if a rise and/or fall of cardiac biomarkers (preferentially troponins) was detected, with at least 1 value above the 99th percentile of the upper reference limit, and in the presence of myocardial ischemia indicators, including related symptoms, ECG changes, and imaging evidence of new loss of viable myocardium or new regional wall-motion abnormalities. The classical diagnostic procedure for AMI (peak creatine kinase level > twice the normal upper limit) was permitted when troponin levels were difficult to assess. Patients who developed AMI, but did not reach the hospital during the acute phase, were diagnosed with recent onset of MI and registered as newly-onset MI cases. Patients who developed AMI-induced cardiac arrest outside the hospital and were not hospitalized were excluded.

**Data Analysis**

Overall, 8,131 AMI patients (5,593 men, 2,538 women) hospitalized between 2004 and 2011 in the Kumamoto Prefecture were registered in this study. Age-adjusted incidence of AMI per 100,000 person-years was calculated. To adjust the age distribution differences among the time periods, we used a direct method with the 2010 Japanese population census as the standard population. We also used the Kumamoto prefectural population per year reported by the Kumamoto Prefecture municipality. Trends in age-adjusted incidence, age-adjusted in-hospital mortality, and cardiac and noncardiac death rates were assessed using the Cochran-Armitage trend test. These analyses were performed using SAS software version 9.3 (SAS institute, Inc, Cary, NC, USA). Statistical significance was set at P<0.05.

**Results**

**Trends and Aging**

The population of the Kumamoto Prefecture remained relatively stable at ~1.8 million people (2004: 1,852,135 people;
Figure 1. Age-adjusted incidence (per 100,000 person-years) of acute myocardial infarction (AMI) has recently decreased, especially in men.

Figure 2. Serial changes in age-adjusted in-hospital mortality after acute myocardial infarction (AMI). Cardiac death rate is maintained at approximately 7%. Although the total and noncardiac death rates appear to have been rising in recent years, no statistically significant difference was observed.

AMI Trends
Figure 1 shows annual trends in overall AMI cases. Every year, approximately 1,000 people developed AMI in the Kumamoto Prefecture (70% men, 30% women); however, since 2010, the number of AMI cases clearly decreased and fell below 900.

2011: 1,812,502 people). However, the proportion of elderly people aged ≥65 years increased annually (2004: 23.18%; 2005: 23.76%; 2006: 24.26%; 2007: 24.71%; 2008: 25.07%; 2009: 25.51%; 2010: 25.65%; 2011: 25.71%, P<0.0001).
The age-adjusted incidence for men decreased significantly (2004: 93.1; 2011: 70.0; P=0.0294), and a decreasing trend among women (2004: 33.0; 2011: 20.7; P=0.0510) and in general (2004: 59.2; 2011: 43.1; P=0.0530) was observed.

**Death Rate Trends in AMI Patients**

Figure 2 shows in-hospital death-rate trends in AMI patients. The age-adjusted cardiac death rate remained relatively constant (~7%) throughout the study. Although the age-adjusted total death rate (2004: 7.7%; 2011: 9.6%) and age-adjusted noncardiac death rate (2004: 0.8%; 2011: 2.5%) increased in recent years, no statistically significant difference was seen. Sepsis, multiple organ failure, and pneumonia comprise >50% of causes of noncardiac death (data not shown).

**Discussion**

This study showed a decline in age-adjusted AMI incidence in the Kumamoto Prefecture in recent years, where 1 in 4 people are elderly (aged ≥65 years). The proportion of elderly people in the whole of Japan has also increased annually (2004: 19.48%; 2005: 20.16%; 2006: 20.82%; 2007: 21.49%; 2008: 22.10%; 2009: 22.75%; 2010: 23.02%; 2011: 23.28%), but remains smaller than that in the Kumamoto Prefecture. The Kumamoto Prefecture may be entering an era of an aging population. Although the in-hospital cardiac death rate remained unchanged, the noncardiac death rate increased slightly, and appeared to affect the total death rate in this study.

The AMI definition has been revised recently. Creatine kinase levels are not always used for AMI diagnosis and recently, diagnosis has relied primarily on troponin levels. People who would have been diagnosed with unstable angina in earlier years are now being diagnosed with non-ST elevation MI. The increasing trend in the Kumamoto Prefecture aging population suggests that an increase in the number of AMI cases can also be expected. Nevertheless, AMI incidence began to decrease around 2010. Some possible explanations for the decrease in AMI incidence are that current Japanese medical care is conforming to cardiovascular-disease-related guidelines, and administration of lipid-lowering medications is decreasing the risk for ischemic heart disease. In fact, the number of hospitalized cases of AMI in South Korea has also decreased continuously from 2006 to 2010.

According to a study, low mortality rates were maintained in MI patients after coronary intervention. Here, however, the total death rate increased slightly, but not significantly. Unlike previous reports including data from a limited number of institutions, our study included all AMI cases in the Kumamoto Prefecture, and this may have affected our results. Even if cardiac death rates were maintained, noncardiac death rates increased, thus possibly increasing the total death rate.

With regard to the study’s limitations, ST-segment change in the acute phase of MI was not investigated. The changing definition of AMI has possibly affected the number of MI diagnoses, with an increase in micro-infarct detection. The KACE study has continued annual registrations and started investigation of ST-segment change and use of troponin levels for the diagnosis of AMI since 2012.

The KACE study demonstrates a steady trend of decreasing AMI incidence, and in-hospital cardiac mortality remains low. Urgent measures should be taken against noncardiac mortality in patients of advanced age in this era of an aging population.

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**Supplementary File**

Supplementary File 1  
Appendix S1.  KACE Study investigators

Please find supplementary file(s):  
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