Multicenter Cohort Study of Acute Myocardial Infarction in Korea
– Interim Analysis of the Korea Acute Myocardial Infarction Registry-National Institutes of Health Registry –

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Background: The Korea Acute Myocardial Infarction Registry (KAMIR)-National Institutes of Health (NIH) registry has the aim of evaluating the clinical characteristics, management, and long-term outcomes of patients with acute myocardial infarction (AMI) in Korea.

Methods and Results: Patients hospitalized for AMI in 20 tertiary university hospitals in Korea have been enrolled since November 2011. The study is expected to complete the scheduled enrollment of approximately 13,000 patients in October 2015, and follow-up duration is up to 5 years for each patient. As of October 2015, an interim analysis of 13,623 subjects was performed to understand the baseline clinical profiles of the study population. The mean age was 64.1 years; 73.5% were male; and 48.2% were diagnosed with ST-segment elevation AMI. Hypertension is a leading cause of AMI in Korea (51.2%), followed by smoking (38.5%) and diabetes mellitus (28.6%). Percutaneous coronary intervention was performed in 87.4% and its success rate was very high (99.4%). In-hospital, 1-year, and 2-year mortality rates were 3.9%, 4.3%, and 8.6%, respectively. The rates of major adverse cardiac events at 1 and 2 years were 9.6% and 18.8%, respectively.

Conclusions: This analysis demonstrated the clinical characteristics of Korean AMI patients in comparison with those of other countries. It is necessary to develop guidelines for Asian populations to further improve their prognosis.

Key Words: Multicenter study; Myocardial infarction; Research design

A cute myocardial infarction (AMI) is a leading cause of death around the world.1,2 In Korea, as in other developed countries, the incidence of AMI has increased over several decades. It is important to prevent the occurrence of AMI, and to manage the patients for a long time after surviving an AMI. To improve the prognosis, we needed to investigate the risk factors, clinical features, use of medications, and procedural findings of AMI in Korean patients. The Korea Acute Myocardial Infarction Registry (KAMIR) was launched for this purpose by the Korean Society of Cardiology in 2005.3,4 However, there were some limitations in the KAMIR, including lack of long-term follow-up, despite a great expansion in the number of enrollments. Therefore, there has been a systematic effort to develop a national registry funded by the

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National Institutes of Health (NIH) for better understanding of AMI in Korea. The authors have established this registry to identify the overall clinical features, current treatment strategies, and prognosis of patients with AMI in Korea and to compare this registry with those from other countries.

**Methods**

**Objectives of the Registry**

The KAMIR-NIH registry (http://www.kamir.or.kr) is a prospective, open, observational, and on-line registry with a multicenter cohort study that is currently ongoing. The registry protocols of KAMIR-NIH were verified and approved by the institutional review board of each participating center. Patients with a diagnosis of AMI at presentation to hospital have been enrolled and followed up continuously. The aims of the KAMIR-NIH are as follows: (1) to collect data on baseline clinical characteristics, current treatment patterns, and short- and long-term patient outcomes; (2) to analyze the prognostic factors of AMI; and (3) to improve the long-term prognosis of individual patients.

**Patients**

Patients hospitalized for AMI from 20 tertiary university hospitals capable of percutaneous coronary intervention (PCI) have been consecutively enrolled since November 2011 throughout Korea. The planned enrollment of approximately 13,000 patients is expected to be complete in October 2015, with follow-up through 2018. AMI is defined as cardiomyocyte necrosis in a clinical setting consistent with acute myocardial ischemia. AMI was diagnosed by the characteristic presentation, serial changes on ECG suggesting infarction, and an increase in cardiac markers, preferably cardiac troponins, with at least one value above the 99th percentile of the upper reference limit. ST-segment elevation MI (STEMI) was defined as new STE elevation in ≥2 contiguous leads, measuring >0.2 mV in leads V1–3 or 0.1 mV in all other leads, or a new left bundle branch block on 12-lead ECG with a concomitant increase in troponin-I or -T.

**Data Collection**

Written informed consent was given by each patient. If patients were unable to give consent because of disease severity, informed consent was obtained from a relative or legal representative. Data were collected by the attending physician with the assistance of a trained clinical research coordinator, via a web-based case report form in the Clinical Data Management System (iCREaT) of the Korea NIH. The KAMIR-NIH registry documented all consecutive variables and values at baseline admission of patients with AMI in Korea. The cardiovascular risk factors (hypertension, diabetes mellitus, dyslipidemia, smoking, and family history of coronary artery disease) and other comorbidities were identified. The baseline data included the initial presentation and laboratory results at the emergency department. During the in-hospital period, events including all-cause death, cardiac death, and any complications related to AMI were recorded. After discharge, all major adverse cardiac events (MACE) including cardiac death, MI, repeat PCI (target lesion or target vessel revascularization, or non-target vessel revascularization), stent thrombosis, or coronary bypass graft, and all events of non-cardiac death, cerebrovascular accident, and re-hospitalization because of heart failure were recorded at 6, 12, 24, and 36 months. The follow-up results of echocardiography, laboratory studies, and prescribed medications were also recorded at 12, 24, and 36 months. The follow-up data were collected from the patients by attending physicians and the web-based case report forms were completed. If the patients did not visit the hospitals, the outcome data were assessed by telephone interview.

**Study Management**

The registry is governed and managed by a committee consisting of healthcare professionals with expertise in AMI. The committee designed the study protocol and case report forms. The committee supervises all activities related to publications from the aggregate database. The present study is funded by the Korea NIH.

**Statistical Methods and Sample Size Determination**

**Determination of Sample Size and Study Power**

For determination of sample size, we selected the timeliness of reperfusion therapy as a representative index. From the previous KAMIR data set, a total of 10,950 (53%) patients were diagnosed with STEMI and underwent PCI. Among these patients, 47% were untimely (>90 min) \( \{Pr(x=1)\}. \) The mortality rate of patients who experienced appropriate reperfusion therapy (≤90 min), was 7% within 1 year \( \{Pr(y=1|x=0)\}. \) We presumed that the odds ratio (OR) of death in 1 year because of delayed reperfusion therapy was 1.3, which minimally expected 80% of the OR of 1.57 in a previous study.8 To observe >80% power and an alpha of 0.05, we needed a sample size of 6,293 calculated by StudySize software (ver. 2.0.4; CreosStat HB, Sweden). In addition, we presumed that the rate of follow-up loss was approximately 10%, requiring a total of 6,923 STEMI patients. Therefore, a total of 13,000 AMI patients were planned to be enrolled in this study, because the proportion of STEMI was 53%. We estimated that a total of 3,000 AMI patients would be annually enrolled from 20 centers, and that we might need 4 years to complete this cohort study.

**Statistical Analysis**

For continuous variables, the data are expressed as the mean±standard deviation or as the median with an interquartile range using unpaired t-test or Mann-Whitney rank-sum test. For categorical variables, the data are expressed as counts and percentage and analyzed by the Chi-square (or Fisher’s exact) test. Cumulative 2-year MACE-, cardiac death-, and repeat PCI-free survival curves were constructed from Kaplan-Meier survival analyses and compared using log-rank test. All analyses were two-tailed, with clinical significance defined as P<0.05. Statistical analysis was performed using SPSS, version 21.0 for Windows (SPSS-PC, Chicago, IL, USA) and R, version 3.2.2.

**Results**

A total of 13,623 Korean patients with AMI were enrolled in this study until October 2015. We excluded patients whose clinical data were incomplete for interim analyses. A total of 12,956 patients were enrolled at 20 hospitals around Korea.

**Demographics and Baseline Clinical Characteristics**

The clinical characteristics of the patients in KAMIR-NIH are shown in Table 1, and they are compared with other AMI registries including GRACE,10 SCAAR,11 NRMI,12 MINAP,13 and SWEDEHEART/RIKS-HIA.14 The mean age was 64.1 years and 73.5% were male. Less than half of the patients (48.2%) were diagnosed as STEMI. Among the risk factors for ischemic heart disease, hypertension was the most common comorbidity (51.2%), followed by smoking (38.5%), diabetes mellitus (28.6%), dyslipidemia (11.2%), previous MI (8.1%), family history (6.3%), and cerebrovascular accident...
only smoking was more frequent in STEMI patients (43.9% vs. 34.4%, P<0.001). STEMI patients had a higher Killip class (22.8% vs. 20.2%, P<0.001) and a higher proportion of significant atrioventricular block (1.4% vs. 0.6%, P<0.001).

Baseline Laboratory and Echocardiographic Findings
As shown in Table 2, the mean white blood cell count was higher (11,500 ± 4,200/mm³ vs. 9,600 ± 5,000/mm³, P<0.001) and the proportion of lymphocyte count (25.3 ± 14.3% vs. 24.0 ± 11.8%, P<0.001) was higher in patients with STEMI. Although the mean level of glucose at presentation was higher (6.2%).

Table 1. Clinical Characteristics of Patients With Acute MI in Korea Compared With Other Registries

| Region                  | KMAIR-NIH | KAMIR   | GRACE    | SCAAR    | NRMI     | MINAP    | SWEDEHEART/RIKS-HIA |
|-------------------------|-----------|---------|----------|----------|----------|----------|---------------------|
| Time period             | South Korea | Nov 2011–Oct 2015 | South Korea | Nov 2005–Oct 2010 | Europe, America | 2004–2007 | Sweden | US | UK | Sweden |
| Sample size             | 13,624    | 27,852  | 28,449   | 19,771   | 542,008  | 391,077  | 119,786             |
| Follow-up rate (%)      | 97.1*     | NA      | 89.8     | 95.2     | NA       | NA       | NA                  |
| Follow-up duration      | 525.6 days | 231.6 days | 2 years  | 3 years  | NA       | NA       | NA                  |
| Demographics            |           |         |          |          |          |          |                     |
| Mean or median age (years) | 64.1    | 63.2    | 65.0     | 65.7     | 64.0     | 69.5     | 71.2                |
| Male (%)                | 73.5      | 75.0    | 68.4     | 72.0     | 59.0     | 65.2     | 63.7                |
| Comorbidities (%)       |           |         |          |          |          |          |                     |
| Hypertension            | 51.2      | 45.9    | 64.7     | 44.5     | 52.3     | 47.3     | 45.2                |
| DM                      | 28.6      | 24.6    | 25.2     | 18.1     | 22.4     | 17.6     | 22.7                |
| Dyslipidemia            | 11.2      | 9.5     | 53.0     | NA       | 28.0     | NA       | NA                  |
| Smoking                 | 38.5      | 62.8    | 59.8     | 20.4     | 31.3     | 29.5     | 23.3                |
| Previous MI             | 8.1       | 11.1    | 30.3     | 37.4     | NA       | 18.3     | 22.4                |
| Family history of CAD   | 6.3       | 7.9     | NA       | NA       | 28.0     | NA       | NA                  |
| CVA                     | 6.2       | 5.6     | NA       | 6.0      | NA       | 8.5      | 10.1                |
| HF                      | 1.8       | 1.1     | 8.8      | 7.4      | NA       | 5.3      | 9.7                 |
| Vital signs             |           |         |          |          |          |          |                     |
| SBP (mmHg)              | 129.9     | 126.8   | NA       | NA       | 147.0    | 139.0    | 145.0               |
| DBP (mmHg)              | 78.4      | 78.0    | NA       | NA       | NA       | NA       | NA                  |
| Pulse rate (/min)       | 78.7      | 76.4    | NA       | NA       | 86.0     | 79.0     | 78.0                |
| STEMI (%)               | 48.2      | 56.6    | 35.9     | 22.6     | 41.8     | 40.3     | 32.1                |
| Multivessel disease (%) | 54.3      | 52.7    | NA       | 50.0     | NA       | NA       | NA                  |
| Culprit artery (%)      |           |         |          |          |          |          |                     |
| LM                      | 2.3       | 1.2     | NA       | 1.3      | NA       | NA       | NA                  |
| LAD                     | 46.7      | 52.7    | NA       | 44.7     | NA       | NA       | NA                  |
| LCX                     | 17.5      | 9.5     | NA       | 21.5     | NA       | NA       | NA                  |
| RCA                     | 33.7      | 36.6    | NA       | 28.8     | NA       | NA       | NA                  |
| PCI rate (%)            | 87.4      | 84.2    | NA       | NA       | 64.0     | 39.7     | 87.9                |
| DES (%)                 | 96.9      | 91.1    | NA       | 30.5     | NA       | NA       | NA                  |
| PCI success rate (%)    | 99.4      | 99.0    | NA       | NA       | NA       | NA       | NA                  |
| In-hospital mortality (%)| 3.9     | 2.0     | NA       | 8.0      | 10.6     | 7.7      |                     |
| 1-year mortality (%)    | 4.3       | 3.1     | NA       | NA       | NA       | NA       | NA                  |
| 2-year mortality (%)    | 8.6       | NA      | 5.7      | NA       | NA       | NA       | NA                  |
| 3-year mortality (%)    | NA        | NA      | 7.2      | NA       | NA       | NA       | NA                  |

*Rate of follow-up at 6 months. CAD, coronary artery disease; CVA, cerebrovascular accident; DBP, diastolic blood pressure; DES, drug eluting stents; DM, diabetes mellitus; GRACE, the Global Registry of Acute Coronary Events; HF, heart failure; KAMIR, Korea Acute Myocardial Infarction Registry; LAD, left anterior descending artery; LCX, left circumflex artery; LM, left main; MI, myocardial infarction; MINAP, Myocardial Ischaemia National Audit Project; NA, not available; NIH, National Institutes of Health; NRMI, National Registry of Myocardial Infarction; PCI, percutaneous coronary intervention; RCA, right coronary artery; SBP, systolic blood pressure; SCAAR, Swedish Coronary Angiography and Angioplasty Registry; STEMI, ST-segment elevation myocardial infarction; SWEDEHEART/RIKS-HIA, Swedish Web-System for Enhancement and Development of Evidence-Based Care in Heart Disease Evaluated According to Recommended Therapies/Register of Information and Knowledge about Swedish Heart Intensive care Admissions; UK, United Kingdom; US, United States.

(6.2%). In Table 2, we compare the baseline characteristics according to the diagnosis: STEMI vs. non-STEMI (NSTEMI). STEMI patients were younger (62.8±12.8 years vs. 65.1±12.4 years, P<0.001), male-predominant (77.7% vs. 70.6%, P<0.001), and more obese (body mass index 24.1±3.4 kg/m² vs. 23.9±3.5 kg/m², P=0.012) than NSTEMI patients. Although most of the patients with STEMI (90.8%) complained of chest pain, only 19.9% utilized the emergency medical service in Korea. Hypertension (54.8% vs. 47.0%, P<0.001), diabetes mellitus (32.0% vs. 24.8%, P<0.001), dyslipidemia (11.8% vs. 10.6%, P=0.022), cerebrovascular accident (7.5% vs. 4.8%, P<0.001), and heart failure (2.3% vs. 0.9%, P<0.001) were more frequent in patients with NSTEMI than STEMI. Only smoking was more frequent in STEMI patients (43.9% vs. 34.4%, P<0.001). STEMI patients had a higher Killip class (22.8% vs. 20.2%, P<0.001) and a higher proportion of significant atrioventricular block (1.4% vs. 0.6%, P<0.001).
KIM JH et al.

Comparison of the Medications Prescribed During Hospitalization

The medications prescribed during hospitalization of the STEMI and NSTEMI patients are shown in Table 4. In Korea, almost all patients are treated with aspirin whether they are diagnosed as STEMI (99.6%) or NSTEMI (99.4%). Clopidogrel was more frequently prescribed for NSTEMI patients (82.4% vs. 74.8%, P<0.001), whereas prasugrel and ticagrelor were more often used for STEMI patients (14.4% vs. 9.6%, P<0.001 and 21.5% vs. 18.0%, P<0.001, respectively). Beta-blockers and renin-angiotensin-aldosterone system blockers were used

| Table 2. Comparison of Baseline Characteristics of Patients With Diagnosis of STEMI and NSTEMI |
|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| Name of parameter                              | STEMI (n=6,246)                              | NSTEMI (n=6,710)                              |
| Age (years)                                    | 62.8±12.8                                    | 65.1±12.4                                    |
| Sex (%)                                        |                                               |                                               |
| Male                                           | 4,853 (77.7)                                  | 4,738 (70.6)                                  |
| Female                                         | 1,393 (22.3)                                  | 1,972 (29.4)                                  |
| Height (cm)                                    | 165.4±8.4                                    | 163.8±8.7                                    |
| Weight (cm)                                    | 66.2±12.0                                    | 64.5±12.1                                    |
| BMI (kg/m²)                                    | 24.1±3.4                                     | 23.9±3.5                                     |
| AC (cm)                                        | 87.7±8.9                                     | 87.4±9.0                                     |
| Symptoms                                       |                                               |                                               |
| Chest pain                                     | 5,673 (90.8)                                  | 5,500 (82.0)                                  |
| Dyspnea                                        | 1,261 (20.2)                                  | 1,800 (26.8)                                  |
| Previous angina                                 | 1,346 (21.5)                                  | 1,973 (29.4)                                  |
| First medical contact                          |                                               |                                               |
| PCI center                                      | 1,758 (28.1)                                  | 2,437 (36.3)                                  |
| Non-PCI center                                  | 3,248 (52.0)                                  | 3,547 (52.9)                                  |
| EMS                                            | 1,240 (19.9)                                  | 726 (10.8)                                    |
| Previous history                               |                                               |                                               |
| MI                                             | 370 (5.9)                                     | 645 (9.6)                                     |
| PCI                                            | 518 (8.3)                                     | 926 (13.8)                                    |
| CABG                                           | 25 (0.4)                                      | 94 (1.4)                                      |
| Risk factors                                   |                                               |                                               |
| Hypertension                                   | 2,935 (47.0)                                  | 3,677 (54.8)                                  |
| DM                                             | 1,551 (24.8)                                  | 2,149 (32.0)                                  |
| Smoking                                        | 2,744 (43.9)                                  | 2,305 (34.4)                                  |
| Dyslipidemia                                   | 659 (10.6)                                    | 794 (11.8)                                    |
| Family history                                 | 380 (6.1)                                     | 444 (6.6)                                     |
| CVA                                            | 302 (4.8)                                     | 502 (7.5)                                     |
| HF                                             | 56 (0.9)                                      | 155 (2.3)                                     |
| Physical findings                              |                                               |                                               |
| SBP (mmHg)                                     | 125.3±31.9                                    | 134.3±28.2                                    |
| DBP (mmHg)                                     | 76.5±20.1                                     | 80.4±16.7                                     |
| Heart rate (beats/min)                         | 76.9±20.7                                     | 80.1±18.6                                     |
| Killip class                                    |                                               |                                               |
| I                                              | 4,801 (77.2)                                  | 5,340 (79.8)                                  |
| II–IV                                          | 1,445 (22.8)                                  | 1,370 (20.2)                                  |
| ECG findings                                   |                                               |                                               |
| Sinus rhythm                                   | 5,308 (85.0)                                  | 5,896 (87.9)                                  |
| AV block (II/III)                              | 89 (1.4)                                      | 38 (0.6)                                      |
| AF/AFL                                         | 340 (5.4)                                     | 348 (5.2)                                     |
| VT/VF                                          | 88 (1.4)                                      | 51 (0.8)                                      |

Data given as number (%) or mean±SD. AC, abdominal circumference; AF, atrial fibrillation; AFL, atrial flutter; AV, atrioventricular; BMI, body mass index; CABG, coronary artery bypass graft; DBP, diastolic blood pressure; ECG, electrocardiogram; EMS, emergency medical service; NSTEMI, non-STEMI; SD, standard deviation; VF, ventricular fibrillation; VT, ventricular tachycardia. Other abbreviations as in Table 1.

in STEMI patients (178.3±81.8 mg/dl vs. 161.8±82.1 mg/dl, P<0.001), there was no significant difference in hemoglobin A1c levels (6.5%±1.5% vs. 6.5±1.5%, P=0.069). Patients with STEMI had higher levels of total cholesterol (180.6±46.1 mg/dl vs. 175.0±46.4 mg/dl, P<0.001), triglyceride (139.8±124.5 mg/dl vs. 128.9±114.9 mg/dl, P<0.001), and low-density lipoprotein (LDL) cholesterol (113.8±38.7 mg/dl vs. 109.6±39.6 mg/dl, P<0.001) than patients with NSTEMI. The mean left ventricular ejection fraction at presentation was lower in STEMI patients (50.1±10.4% vs. 53.5±11.7%, P<0.001).
## Table 3. Baseline Laboratory and Echocardiographic Findings in Patients With Diagnosis of STEMI and NSTEMI

| Laboratory findings                        | STEMI (n=6,246) | NSTEMI (n=6,710) | P value |
|--------------------------------------------|-----------------|------------------|---------|
| **WBC (/mm³)**                             | 11,500±4,200    | 9,600±5,000      | <0.001  |
| Neutrophils (%)                            | 66.3±16.3       | 66.6±14.1        | 0.350   |
| Lymphocytes (%)                            | 25.3±14.3       | 24.0±11.8        | <0.001  |
| Hemoglobin (g/dl)                          | 14.2±3.4        | 13.4±2.2         | <0.001  |
| Platelets (×1,000/mm³)                     | 236.1±68.3      | 229.1±68.6       | <0.001  |
| Glucose (mg/dl)                            | 178.3±81.8      | 161.8±82.1       | <0.001  |
| Creatinine (mg/dl)                         | 1.0±0.8         | 1.2±2.9          | <0.001  |
| Total cholesterol (mg/dl)                  | 180.6±46.1      | 175.0±46.4       | <0.001  |
| Triglyceride (mg/dl)                       | 139.8±124.5     | 128.9±114.9      | <0.001  |
| HDL-C (mg/dl)                              | 42.6±12.3       | 43.1±12.7        | 0.054   |
| LDL-C (mg/dl)                              | 113.8±38.7      | 109.6±39.6       | <0.001  |
| CK-MB (ng/ml)                              | 166.4±189.6     | 58.5±115.4       | <0.001  |
| Troponin-I (ng/ml)                         | 80.4±396.3      | 22.1±54.4        | <0.001  |
| NT-proBNP (pg/ml)                          | 1,693.8±4,889.2 | 3,491.2±7,360.7  | <0.001  |
| hs-CRP (mg/dl)                             | 1.6±12.8        | 5.6±234.0        | 0.295   |
| HbA1c (%)                                  | 6.5±1.5         | 6.5±1.5          | 0.069   |
| Aspirin (mg/dl)                            | 456.8±76.3      | 462.5±72.6       | 0.042   |
| P2Y12 reaction units                       | 182.2±108.7     | 218.1±108.2      | <0.001  |

**Echocardiographic findings**

| Laboratory findings                        | STEMI (n=6,246) | NSTEMI (n=6,710) | P value |
|--------------------------------------------|-----------------|------------------|---------|
| LVEF (%)                                   | 50.1±10.4       | 53.5±11.7        | <0.001  |
| RWMI                                       | 1.5±0.4         | 1.4±0.4          | <0.001  |
| LVESD (mm)                                 | 35.2±8.2        | 34.8±8.6         | 0.034   |
| LVEDD (mm)                                 | 49.6±6.4        | 49.8±6.9         | 0.089   |
| LVESV (ml)                                 | 48.3±23.0       | 47.0±27.3        | 0.046   |
| LVEDV (ml)                                 | 95.3±47.6       | 94.7±36.3        | 0.572   |

Data expressed as mean±SD. CK-MB, creatine kinase-MB; Hb, hemoglobin; HDL-C, high-density lipoprotein cholesterol; hs-CRP, high-sensitivity C-reactive protein; LDL-C, low-density lipoprotein cholesterol; NT-proBNP, N-terminal pro B-type natriuretic peptide; LVESD, left ventricular end-systolic diameter; LVEDV, left ventricular end-diastolic volume; LVEF, left ventricular ejection fraction; LVESV, left ventricular end-systolic volume; RWMI, regional wall motion index; WBCC, white blood cell count. Other abbreviations as in Tables 1,2.

## Table 4. Comparison of the Medications Prescribed During Hospitalization of Patients With Diagnosis of STEMI and NSTEMI

| Medications       | STEMI (n=6,246) | NSTEMI (n=6,710) | P value |
|-------------------|-----------------|------------------|---------|
| **Antiplatelet agents** |                 |                  |         |
| Aspirin           | 6,223 (99.6)    | 6,670 (99.4)     | 0.082   |
| Clopidogrel       | 4,674 (74.8)    | 5,527 (82.4)     | <0.001  |
| Cilostazol        | 685 (11.0)      | 693 (10.3)       | 0.250   |
| Prasugrel         | 898 (14.4)      | 645 (9.6)        | <0.001  |
| Ticagrelor        | 1,342 (21.5)    | 1,208 (18.0)     | <0.001  |
| **β-blockers**    |                 |                  |         |
| ACEIs             | 3,223 (51.6)    | 2,747 (40.9)     | <0.001  |
| ARBs              | 1,639 (26.2)    | 2,408 (35.9)     | <0.001  |
| CCBs              | 257 (4.1)       | 797 (11.9)       | <0.001  |
| Statin            | 5,622 (90.0)    | 6,008 (89.5)     | 0.392   |
| Omega-3 fatty acid| 214 (3.4)       | 161 (2.4)        | 0.001   |
| Oral hypoglycemic agents | 1,041 (16.7) | 1,302 (19.4)     | <0.001  |

Data expressed as number (%). *All cases of patients using any antiplatelet agent at loading or maintenance dose are included. ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin II receptor blocker; CCB, calcium-channel blocker. Other abbreviations as in Tables 1,2.
in approximately 80% of all patients. Angiotensin-converting enzyme inhibitors were used in 51.6% of STEMI patients and 40.7% of NSTEMI patients. Angiotensin II receptor blockers were also used in one-third of all patients: 26.2% of STEMI and 35.9% of NSTEMI. Almost all patients (90%) were prescribed a stain whether they were diagnosed as STEMI or NSTEMI.

**Coronary Angiographic and Procedural Findings**

As shown in Table 1 and Table 5, coronary angiography was performed in almost all the patients, but more commonly in the patients with STEMI (99.3% vs. 97.5%, P<0.001). The overall rate of PCI in all patients was 87.4%: 96.7% of STEMI and 82.9% of NSTEMI. The procedural success rate of was very high, regardless of the diagnosis (98.5% in STEMI; 98.9% in NSTEMI; P=0.088). The transfemoral approach was used more frequently than the transradial approach in STEMI patients (74.2% vs. 25.2%, P<0.001). The rate of using drug-eluting stents (DES) was 97.0% among STEMI patients and 96.9% among NSTEMI, and the details were not different.
Interim Analysis of KAMIR-NIH

A successor of the previous KAMIR registry. The KAMIR was developed for the prevention and management of AMI in Korea\textsuperscript{3,6,7} and this interim analysis of the cohort study had some valuable findings of AMI in an Asian population. The Korean patients had different clinical profiles in comparison with those from Western countries. First of all, the proportion of STEMI was still high in Korea. Among Korean AMI patients, STEMI decreased from 56.6\% of KAMIR to 48.2\% of KAMIR-NIH. Hypertension was the most common risk factor in Korean patients with AMI, as in other registries. Interestingly, compared with the previous KAMIR registry, KAMIR-NIH showed a decrease in the prevalence of smoking in Korea, reflecting a national effort for cessation of smoking over the decade. The prevalence of diabetes mellitus was higher, and the prevalence of dyslipidemia and previous MI was lower than in other countries. On subgroup analysis, NSTEMI patients had higher rates of comorbidities, except smoking. The prevalence of diabetes mellitus has rapidly increased, especially in aging countries.\textsuperscript{14} Diabetes mellitus is related to greater endothelial dysfunction, inflammatory processes,\textsuperscript{15} and greater atherosclerosis burden, with more diffuse and more multivessel disease.\textsuperscript{14} These result in a higher prevalence of multivessel disease, which might be associated with poor prognosis. In contrast, the patients with STEMI were younger than those with NSTEMI, and they less frequently had comorbidities. This discrepancy was consistent with a previous analysis of the KAMIR registry,\textsuperscript{6} and more frequent comorbidities in NSTEMI patients might result from the

### In-Hospital and Post-Discharge Outcomes

As shown in Table 6, approximately 20\% of all patients experienced complications: 24.9\% of STEMI and 15.9\% of NSTEMI patients. The most common complication was cardiogenic shock (8.4\%), followed by newly developed heart failure (4.8\%), atrial fibrillation (3.3\%), and minor bleeding (3.0\%). Overall in-hospital mortality was 3.9\%: 5.1\% in STEMI and 2.6\% in NSTEMI patients. The most common cause of in-hospital death was pump failure (2.6\%). After discharge, the median of follow-up period was 525.6 days, and the composite rates of MACE at 6 months, 12 months, and 24 months were 4.4\%, 9.6\%, and 18.8\%, respectively (Figure). The rates of cardiac death, non-cardiac-death, MI, and repeat PCI at 24 months were 5.2\%, 3.4\%, 4.5\%, and 9.0\%, respectively. During 2 years, 6.8\% of all patients were readmitted for heart failure.

### Discussion

The KAMIR-NIH is an extending and expanding study that is a successor of the previous KAMIR registry. The KAMIR was developed for the prevention and management of AMI in Korea\textsuperscript{3,6,7} and this interim analysis of the cohort study had some valuable findings of AMI in an Asian population. The Korean patients had different clinical profiles in comparison with those from Western countries. First of all, the proportion of STEMI was still high in Korea. Among Korean AMI patients, STEMI decreased from 56.6\% of KAMIR to 48.2\% of KAMIR-NIH. Hypertension was the most common risk factor in Korean patients with AMI, as in other registries. Interestingly, compared with the previous KAMIR registry, KAMIR-NIH showed a decrease in the prevalence of smoking in Korea, reflecting a national effort for cessation of smoking over the decade. The prevalence of diabetes mellitus was higher, and the prevalence of dyslipidemia and previous MI was lower than in other countries. On subgroup analysis, NSTEMI patients had higher rates of comorbidities, except smoking. The prevalence of diabetes mellitus has rapidly increased, especially in aging countries.\textsuperscript{14} Diabetes mellitus is related to greater endothelial dysfunction, inflammatory processes,\textsuperscript{15} and greater atherosclerosis burden, with more diffuse and more multivessel disease.\textsuperscript{14} These result in a higher prevalence of multivessel disease, which might be associated with poor prognosis. In contrast, the patients with STEMI were younger than those with NSTEMI, and they less frequently had comorbidities. This discrepancy was consistent with a previous analysis of the KAMIR registry,\textsuperscript{6} and more frequent comorbidities in NSTEMI patients might result from the

### Table 6. In-Hospital Complications and Mortality of Patients With Diagnosis of STEMI and NSTEMI

| Complications                  | STEMI (n=6,246) | NSTEMI (n=6,710) | P value |
|-------------------------------|-----------------|------------------|---------|
| Cardiogenic shock             | 1,553 (24.9)    | 1,069 (15.9)     | <0.001  |
| Newly developed HF            | 747 (12.0)      | 340 (5.1)        | <0.001  |
| Recurrent ischemia            | 257 (4.1)       | 322 (4.8)        | 0.066   |
| Stent thrombosis              | 67 (1.1)        | 42 (0.6)         | 0.007   |
| Cerebral infarction           | 32 (0.5)        | 10 (0.1)         | 0.001   |
| Cerebral hemorrhage           | 36 (0.6)        | 45 (0.7)         | 0.570   |
| Significant Hb decrease       | 10 (0.2)        | 6 (0.1)          | 0.141   |
| Minor bleeding                | 188 (3.0)       | 194 (2.9)        | 0.728   |
| AV block                      | 187 (3.0)       | 48 (0.7)         | <0.001  |
| VT                            | 341 (5.5)       | 106 (1.6)        | <0.001  |
| VF                            | 183 (2.9)       | 58 (0.9)         | <0.001  |
| Atrial fibrillation           | 230 (3.7)       | 195 (2.9)        | 0.015   |
| Acute kidney injury           | 56 (0.9)        | 67 (1.0)         | 0.612   |
| Sepsis                        | 39 (0.6)        | 43 (0.6)         | 0.994   |
| Multi-organ failure           | 55 (0.9)        | 39 (0.6)         | 0.057   |
| Cardiac death                 | 316 (5.1)       | 176 (2.6)        | <0.001  |
| Pump failure                  | 278 (4.5)       | 137 (2.0)        | <0.001  |
| Mechanical complications      | 224 (3.6)       | 111 (1.7)        | <0.001  |
| Arrhythmia                    | 25 (0.4)        | 12 (0.2)         | 0.022   |
| Other                         | 6 (0.1)         | 6 (0.1)          | 1.000   |
| Non-cardiac death             | 23 (0.4)        | 8 (0.1)          | 0.001   |
| Multi-organ failure           | 39 (0.6)        | 39 (0.6)         | 0.838   |
| Bleeding                      | 16 (0.3)        | 15 (0.2)         | 0.624   |
| Sepsis                        | 5 (0.1)         | 3 (0.1)          | 0.868   |
| Others                        | 6 (0.1)         | 12 (0.2)         | 0.382   |
| In-hospital mortality         | 12 (0.2)        | 9 (0.1)          | 1.000   |

Data expressed as number (%). Abbreviations as in Tables 2,3.
The previous KAMIR study results supported the strategy of reducing LDL-cholesterol ≥50% from baseline. Recently, the Improved Reduction of Outcomes: Vytorin Efficacy International Trial (IMRPOVE-IT) study proposed that lower is better, and the role of non-statin lipid-lowering agents for improving cardiovascular outcomes. In this clinical setting, the newer KAMIR-NIH registry will investigate the target of LDL-cholesterol and the effect of non-statin agents in an Asian population. The previous studies suggested that clopidogrel resistance develops with higher levels of PRU in Korea.

Although the mean level of PRU was below the cut-off value for clopidogrel resistance in both STEMI and NSTEMI patients, the newer P2Y12 inhibitors,prasugrel and ticagrelor, were used frequently during hospitalization. In the near future the KAMIR-NIH registry will provide data on antiplatelet agent switching. In Korea, most patients with AMI undergo coronary decept old subjects. In addition, NSTEMI would be caused by insidious atherosclerosis rather than sudden interruption of coronary blood flow by plaque rupture, followed by rapid progression of atherothrombosis. Because our interim analysis demonstrated an increase in NSTEMI, the need for treatment strategies for multivessel disease may be commonly encountered in the current clinical setting.

The KAMIR-NIH showed unique laboratory and echocardiographic findings. Levels of LDL-cholesterol were higher and levels of P2Y12 reaction units (PRU) were lower. As already mentioned, the prevalence of dyslipidemia was lower in this cohort study, compared with other registries. However, the levels of LDL-cholesterol were high in both STEMI and in NSTEMI patients. For secondary prevention after AMI, efforts should be made to lower the level of LDL-cholesterol. The previous guidelines recommend LDL-cholesterol goals of either <70mg/dl or ≥50% reduction from baseline, or no specific target. The previous KAMIR study results supported the strategy of reducing of LDL-cholesterol ≥50% from baseline. Recently, the Improved Reduction of Outcomes: Vytorin Efficacy International Trial (IMRPOVE-IT) study proposed that lower is better, and the role of non-statin lipid-lowering agents for improving cardiovascular outcomes. In this clinical setting, the newer KAMIR-NIH registry will investigate the target of LDL-cholesterol and the effect of non-statin agents in an Asian population. The previous studies suggested that clopidogrel resistance develops with higher levels of PRU in Korea. Although the mean level of PRU was below the cut-off value for clopidogrel resistance in both STEMI and NSTEMI patients, the newer P2Y12 inhibitors, prasugrel and ticagrelor, were used frequently during hospitalization. In the near future the KAMIR-NIH registry will provide data on antiplatelet agent switching.

In Korea, most patients with AMI undergo coronary
angiography, and are treated by PCI rather than fibrinolysis or coronary artery bypass graft surgery. There are 98 PCI centers in Korea, the population of which is approximately 51 million, and many AMI patients in Korea may have access to the highly experienced PCI centers certified by the Korean Society of Interventional Cardiology (PCI >100 cases/year). The medical insurance covers the cost of PCI including coronary stents. Therefore, the KAMIR-NIH included almost all angiographic and procedural findings of AMI patients, and the authors are convinced that high-quality data were collected, with a high procedural success rate of 99.4%. Unlike the Western registries, approximately 97% of Korean AMI patients received DES. DES are superior to bare-metal stents in terms of lower rates of target lesion revascularization, but have similar safety outcomes as bare-metal stents. The difference between KAMIR-NIH and KAMIR was that only 1% of AMI patients in KAMIR-NIH had 1st-generation DES. Thus, we should focus on 2nd-generation DES or newer DES for real-world practice. In addition, as mentioned before, we found several differences in the characteristics of Korean AMI patients compared with Western populations. The current clinical guidelines for AMI, whether established by a European or American society, are based on Western populations. We propose that new Asian guidelines reflecting these discrepancies are required for the “real world”.

In this study, in-hospital complications and mortality were compared between STEMI and NSTEMI patients. A trend of poor prognosis in STEMI patients was observed. In-hospital mortality was 5.1%, and 24.9% experienced more than 1 peri-procedural complications. Because pump failure was the most common cause of cardiac death in both STEMI and NSTEMI patients, it is important to reduce total ischemic time to improve prognosis. After discharge, the rates of MACE, including cardiac death, non-cardiac death, MI, and repeat PCI, continued to be high during 24 months, and a large proportion of the MACE was repeat PCI. The KAMIR score was developed for risk stratification and prediction of 1-year mortality using 6 independent variables: age, Killip class, serum creatinine, in-hospital PCI, left ventricular ejection fraction, and admission glucose. This scoring system should be validated with the newer KAMIR-NIH data, and modified appropriately for prediction of long-term clinical outcomes. Additionally, 6.8% of AMI patients were readmitted for heart failure. The symptoms of heart failure are directly related to quality of life, which may thus need to be included as a subjective factor in the newer risk model for assessment of post-AMI outcomes.

Study Limitations
First, it is important to control the quality of follow-up data of ongoing prospective cohort studies. Registry data requires high follow-up and response rates to yield reliable data that can be applied in clinical practice. Second, it was difficult to reflect and update the most recent changes in managing AMI during the follow-up period. Third, the authors need to expand and extend the data for improving clinical effect, especially maintaining long-term follow-up.

In conclusion, an interim analysis of the KAMIR-NIH registry revealed that AMI is a still challenging medical problem associated with high in-hospital mortality and poor long-term clinical outcomes in Korea. There are several differences in the clinical profiles, baseline characteristics, risk factors, management and prognosis of AMI patients in Korea in comparison with other Western AMI registries. Therefore, further research into the prevention and management of AMI is needed for better clinical outcomes, taking into account regional heterogeneity. Ultimately, guidelines for Asian individuals with AMI should be established.

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