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Trends in Hospitalized Acute Myocardial Infarction Patients with Heart Failure in Korea at 1998 and 2008

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Heart failure (HF) complicating acute myocardial infarction (AMI) is common and is associated with poor clinical outcome. Limited data exist regarding the incidence and in-hospital mortality of AMI with HF (AMI-HF). We retrospectively analyzed 1,427 consecutive patients with AMI in the five major university hospitals in Korea at two time points, 1998 (n = 608) and 2008 (n = 819). Two hundred twenty eight patients (37.5%) in 1998 and 324 patients (39.5%) in 2008 of AMI patients complicated with HF (P = 0.429). AMI-HF patients in 2008 were older, had more hypertension, previous AMI, and lower systolic blood pressure than those in 1998. Regarding treatments, AMI-HF patients in 2008 received more revascularization procedures, more evidence based medical treatment and adjuvant therapy, such as mechanical ventilators, intra-aortic balloon pulsation compared to those in 1998. However, overall in-hospital mortality rates (6.4% vs 11.1%, P = 0.071) of AMI-HF patients were unchanged and still high even after propensity score matching analysis, irrespective of types of AMI and revascularization methods. In conclusion, more evidence-based medical and advanced procedural managements were applied for patients with AMI-HF in 2008 than in 1998. However the incidence and in-hospital mortality of AMI-HF patients were not significantly changed between the two time points.

Keywords: Acute Myocardial Infarction; Heart Failure; Temporal Trend; Hospital Mortality

INTRODUCTION

Heart failure (HF) is a health problem worldwide, especially in developed countries, with a major cause of morbidity and mortality, leading to hospitalization (1, 2). Coronary artery disease including acute myocardial infarction (AMI) is the most common cause of HF, while HF is a common serious complication following AMI (3, 4).

In recent decades, introduction of new medical and interventional treatments, such as primary percutaneous revascularization, antiplatelet agents, renin-angiotensin-aldosterone system (RAAS) antagonists, statins, and hemodynamic support system such as intra-aortic balloon pulsation (IABP) and extracorporeal support system (ECS) have been reported to decrease the rate of HF development and in-hospital mortality of AMI patients (5-8). However, some other studies could not find any significant decrease in trends, especially the incidence of HF after AMI (9, 10). Most studies about the trends in the AMI with HF (AMI-HF) were based on data in western countries. However, there are few data whether the improvements of AMI treatment have reduced the incidence or short term in-hospital mortality of HF in Asian countries (11). Accordingly, we sought to investigate temporal trends of AMI-HF in the clinical characteristics, treatment methods and in-hospital mortality in 1998 and 2008, respectively.

MATERIALS AND METHODS

Study design and population

We studied consecutive AMI patients who admitted in the five major university hospitals in Korea at two time points, 1998 and 2008. First, we used the discharge codes as coded by the International Classification of Disease, Tenth Revision, Clinical Modification

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(ICD-10-CM). AMI was defined as I21. We recognized a total of 1,785 patients with this AMI code. Eligible AMI patients for this study had any episodes of chest pain within two weeks of admission and a positive troponin test or electrocardiographic changes (ST-segment deviation ≥ 0.1 mV or pathologic Q wave). A total of 1,513 patients was selected for adopting these diagnostic criteria of AMI. The exclusion criteria were as follows: chest pain onset started two weeks prior to admission, underlying heart failure, estimated life expectancy of less than 12 months.

Baseline characteristics and definition of heart failure

The records of clinical variables were retrieved from patients' electronic medical record. Clinical variables included in the analysis were: age, gender, cigarette smoking, vital sign, family history of vascular disease, route of admission (emergent department, out-patient and in-hospital), co-existing conditions such as hypertension, diabetes mellitus, cerebrovascular accident (CVA), history of AMI one month prior to admission, and dyslipidemia. The location of infarction, treatment modality, additional mechanical treatment, total admission duration, discharge medication, and in-hospital death were also included.

Shock was defined as systolic pressure lower than 90 mmHg. Conservative care of AMI was defined as no reperfusion treatment such as thrombolysis, percutaneous coronary intervention (PCI), and coronary artery bypass graft (CABG). Diagnostic criteria of HF were defined as left ventricular ejection fraction (LVEF) by echocardiography less than 40% or dyspnea with congestion on radiograph.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation and are compared with the Student's t-test. Discrete variables were expressed as percentages and compared with the chi-square test or Fisher's exact test. A multivariate logistic regression analysis was performed in order to identify independent predictors for AMI with HF. Variables which were evaluated in the multivariate logistic regression analysis included using those with significant association ($P < 0.05$) in univariate logistic regression analysis.

A propensity score matching analysis for the predicted probability of in-hospital mortality in each group was estimated with the use of logistic regression model fit with 18 clinically relevant factors. Age, gender, types of AMI (ST elevation MI), underlying comorbidities such as diabetes, hypertension, dyslipidemia, CVA, previous MI and family history, smoking status, systolic blood pressure, heart rate, revascularization methods (PCI and CABG) and adjuvant therapy (ventilator, intra-aortic balloon pump (IABP), inotropes and intensive care unit (ICU) care). We created a propensity score matched by attempting to match case patients and control patients (a 1:1 match). A nearest-neighbor-matching algorithm with a "greedy" heuristic (one that always implements the best immediate, or local, solution) was used to match patients on the demographic characteristics. All other analyses were 2-tailed, with clinical significance defined as values of $P < 0.05$. All statistical analyses were done with Statistical Analysis Software package (SAS version 9.1, SAS Institute, Cary, NC, USA).

Ethics statement

The study protocol was approved by the institutional review board (IRB) at each participating institution. IRB number of Seoul National University Hospital was 1102-072-352 and that of Severance Cardiovascular Hospital was 4-2011-0075. Informed consent was waived by the IRB.

RESULTS

Characteristics of the study populations

The flow chart was briefly presented to illustrate the selection process of study population (Fig. 1). Of 1,785 patients to have AMI coded with I21 (ICD-10-CM), we selected 1,513 subjects who satisfied the diagnostic criteria of AMI. We excluded 86 patients; and a total of 1,427 patients were finally selected in this study. There were 608 (42.6%) patients with AMI at 1998 and 819 (57.4%) at 2008. Baseline demographic and clinical characteristics are shown in Table 1. The patients of 2008 were older and had high proportion of male patients, hypertension, dyslipidemia, and previous AMI but lower prevalence of ST-elevation MI (STEMI) and received more revascularization treatments such as PCI and CABG and lower thrombolysis treat-

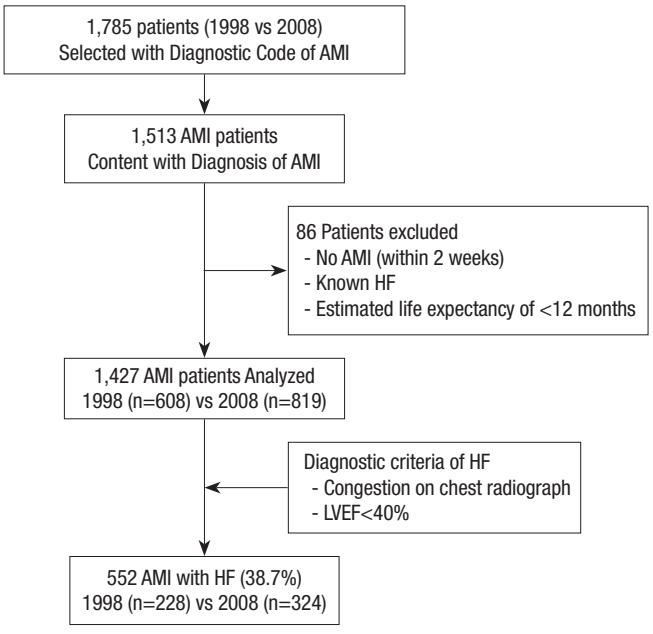

Fig. 1. Study flow chart. AMI, acute myocardial infarction; HF, heart failure; LVEF, left ventricular ejection fraction.

Table 1. Comparison of baseline characteristics of AMI between 1998 and 2008

Characteristics	1998 (n = 608)	2008 (n = 819)	*P* value
Demographics			
Male gender, No. (%)	438 (72.0)	633 (77.4)	0.021
Age (yr)	60.8 ± 12.4	62.8 ± 12.4	0.002
Visit method, No. (%)			0.021
ER	543 (89.3)	759 (92.7)	
OPD	60 (9.9)	57 (7.0)	
In-hospital	5 (0.8)	3 (0.3)	
Transfer from other hospital, No. (%)	176 (29.0)	288 (36.0)	0.006
Diagnostic criteria of AMI, No. (%)			
Chest pain	585 (96.5)	762 (93.6)	0.014
Elevated cardiac enzyme	459 (77.9)	740 (90.5)	< 0.001
ST elevation or Q wave	524 (86.8)	588 (72.8)	< 0.001
STEMI	429 (70.6)	483 (59.0)	< 0.001
Vital sign			
Systolic blood pressure (mmHg)	128.7 ± 29.4	125.6 ± 28.5	0.052
Diastolic blood pressure (mmHg)	78.7 ± 19.0	76.4 ± 18.4	0.019
Heart rate (/min)	77.6 ± 20.8	79.2 ± 20.3	0.148
Shock, No. (%)	35 (5.9)	52 (6.4)	0.692
Medical history, No. (%)			
Diabetes mellitus	161 (26.5)	245 (30.1)	0.140
Hypertension	257 (42.5)	438 (53.5)	< 0.001
Dyslipidemia	84 (14.2)	156 (19.1)	0.016
Smoking	332 (55.5)	467 (57.4)	0.430
CVA	41 (6.8)	51 (6.2)	0.679
Previous MI	30 (4.9)	105 (12.8)	< 0.001
Familial history, No. (%)	98 (16.7)	143 (18.2)	0.464
Location of AMI, No. (%)			
Anteroseptal	326 (55.7)	441 (60.3)	0.093
Inferolateral	332 (56.8)	436 (60.0)	0.239
RV wall	23 (3.9)	59 (8.6)	0.001
LVEF (%)	47.0 ± 12.1	46.4 ± 13.7	0.503
Treatment method, No. (%)			
Thrombolysis	150 (24.7)	18 (2.2)	< 0.001
PCI	329 (54.1)	633 (77.5)	< 0.001
CABG	35 (5.8)	73 (8.9)	0.025
Conservative care	202 (33.2)	105 (12.9)	< 0.001
Admission duration (day)	11.8 ± 13.6	8.4 ± 9.6	< 0.001
Development of HF, No. (%)	228 (37.5)	324 (39.6)	0.429
ICU care duration (day)	5.9 ± 8.0	4.3 ± 6.8	< 0.001
In-hospital death, No. (%)	20 (3.3)	40 (4.9)	0.071

AMI, acute myocardial infarction; ER, emergency room; OPD, out-patient department; STEMI, ST elevation MI; CVA, cerebrovascular accident; MI, myocardial infarction; RV, right ventricle; LVEF, left ventricular ejection fraction; PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft; HF, heart failure; ICU, intensive care unit.

Table 2. Comparison of baseline characteristics with or without HF in AMI

Characteristics	HF (n = 552)	No HF (n = 875)	*P* value
Demographics			
Male gender, No. (%)	389 (70.5)	682 (78.0)	0.002
Age (yr)	64.5 ± 12.9	60.3 ± 11.9	< 0.001
In 2008 (vs In 1998), No. (%)	324 (58.7)	495 (58.6)	0.442
Visit method, No. (%)			
ER	500 (90.6)	802 (91.7)	0.356
OPD	47 (8.5)	70 (8.0)	
In-hospital	5 (0.9)	3 (0.3)	
Transfer from other hospital, No. (%)	217 (39.4)	247 (28.9)	< 0.001
Diagnostic criteria of AMI, No. (%)			
Chest pain	506 (92.3)	841 (96.4)	0.001
Elevated cardiac enzyme	457 (83.4)	742 (86.4)	0.124
ST elevation or Q wave	445 (81.1)	667 (77.3)	0.096
STEMI	363 (65.8)	549 (63.5)	0.333
Vital sign			
Systolic blood pressure (mmHg)	123.7 ± 30.9	128.9 ± 27.4	0.001
Diastolic blood pressure (mmHg)	74.8 ± 18.9	79.0 ± 18.4	< 0.001
Heart rate (/min)	83.5 ± 22.3	75.3 ± 18.6	< 0.001
Shock, No. (%)	49 (8.9)	38 (4.4)	0.001
Medical history, No. (%)			
Diabetes mellitus	178 (32.4)	228 (26.2)	0.013
Hypertension	270 (49.0)	425 (48.8)	0.957
Dyslipidemia	90 (16.5)	150 (17.4)	0.663
Smoking	288 (52.5)	511 (59.2)	0.013
CVA	47 (8.5)	45 (5.2)	0.015
Previous MI	49 (8.9)	86 (9.8)	0.578
Familial history, No. (%)	80 (14.9)	161 (19.3)	0.042
Location of AMI, No. (%)			
Anteroseptal	334 (64.7)	433 (54.1)	< 0.001
Inferolateral	306 (59.4)	462 (58.0)	0.606
RV wall	25 (5.1)	57 (7.3)	0.128
LVEF (%)	40.3 ± 12.8	53.8 ± 9.2	< 0.001
Treatment method, No. (%)			
Thrombolysis	58 (10.5)	110 (12.6)	0.273
PCI	317 (57.5)	645 (73.8)	< 0.001
CABG	71 (12.9)	37 (4.2)	< 0.001
Conservative care	142 (25.8)	165 (18.9)	0.002
Admission duration (day)	12.9 ± 15.9	7.7 ± 7.4	< 0.001
ICU care duration (day)	6.3 ± 9.1	3.1 ± 3.2	< 0.001
In-hospital death, No. (%)	45 (9.2)	15 (4.0)	0.004

HF, heart failure; AMI, acute myocardial infarction; ER, emergency room; OPD, out-patient department; STEMI, ST elevation MI; CVA, cerebrovascular accident; MI, myocardial infarction; RV, right ventricle; LVEF, left ventricular ejection fraction; PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft; ICU, intensive care unit.

ment and had shorter ICU care duration, compared to those in 1998.

Characteristics of AMI patients with or without HF

Considering the definition of HF as LVEF less than 40% or dyspnea with congestion on chest radiograph, a total of 552 (38.7%) patients had AMI with HF. The AMI patients with HF were more female gender, older, and had a higher incidence of transfer from other hospital, absence of chest pain at the initial presentation, lower systolic blood pressure, diabetes mellitus, smoking, CVA, family history and more anteroseptal MI, less received PCI, more received CABG, and longer admission and ICU care duration (Table 2). Multivariate logistic regression analysis showed that old age, transfer from other hospital, absence of chest pain, lower systolic blood pressure, increased heart rate and anteroseptal MI were independent predictors for AMI with HF (Table 3). In 1998, old age, transfer from other hospital, increased heart rate and anteroseptal MI were independent predictors for AMI-HF. In 2008, old age, transfer from other hospital, absence of chest pain, lower systolic blood pressure and anteroseptal MI were independently related to AMI-HF (Table 4). The AMI patients with HF in 2008 were older, had a higher prevalence of hypertension, previous AMI, and had more active treatment such as adjuvant therapy (e.g. ventilator, IABP, extracorporeal membrane oxygenation (ECMO) and inotropics), medical therapy (e.g. antiplatelets, beta blocker, RAAS antagonists, and statin) and lower systolic blood pressure compared to those in 1998. However, there was no significant differ-

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ence for the incidence and overall in-hospital mortality of AMI-HF between the two time points (Table 5). To compare in-hospital mortality properly considering the severity of AMI-HF patients, propensity score matching analysis was done with 18 relevant clinical variables. However in-hospital mortality was not improved between the two time points irrespective of types of AMI and revascularization methods (Supplementary Table 1-3).

DISCUSSION

The major finding of this study is that despite major advances in the management of AMI, the incidence and in-hospital mortality of AMI-HF remained unchanged and still high. During the past few decades, advance of interventional treatment (e.g. IABP, DES) and induction of new medical treatments such as antiplatelet agents, beta-blocker, RAAS antagonists, and statins have markedly improved long term prognosis of patients with AMI (5-7, 12). In our study, while short term in-hospital mortality rate (3.3% vs 4.9%) was comparable to other previous studies but it was not decreased from 1998 to 2008. Considering the disparity in clinical severity between two time points in our study, increased hospital accessibility and advanced salvage treatments of high-risk AMI patients in recent time point may contribute to these unchanged trends.

Table 3. Independent predictors for AMI with HF in overall population (both 1998 and 2008)

Parameters	OR	95% CI	*P* value
Age (yr)	1.024	1.013-1.035	< 0.001
Male gender	0.846	0.610-1.174	0.317
Transfer from other hospital	1.688	1.303-2.185	< 0.001
Chest pain	0.500	0.276-0.906	0.022
Systolic blood pressure (mmHg)	0.992	0.987-0.996	< 0.001
Heart rate (/min)	1.019	1.013-1.026	< 0.001
Diabetes mellitus	1.249	0.954-1.635	0.105
Smoking	0.941	0.710-1.248	0.674
CVA	1.399	0.844-2.319	0.193
Familial history	0.932	0.676-1.285	0.667
Anteroseptal infarction	1.526	1.188-1.960	0.001

AMI, acute myocardial infarction; HF, heart failure; OR, odds ratio; CI, confidence interval; CVA, cerebrovascular accident.

Regarding HF complicating AMI, Hellermann et al. (13) showed that compared to 1979, there was a 28% reduction in the incidence of heart failure after AMI at 1994 in the Unites States. In Framingham Heart Study, compared with the period 1970 to 1979, the investigators observed higher risk of heart failure and lower risk of mortality rate in the period 1990 to 1999 (9). Consistently, in Canada, 5 yr rate of HF development increased by 25%, whereas 5 yr mortality rate after MI decreased by 28% (10). The incidence of AMI with HF did not change from 1998 to 2008 in our study, comparable to other studies (4). However, most epidemiologic studies about the trends in the incidence of HF after AMI have been conducted in Western countries. Recently, the striking differences in outcomes after AMI were observed in the different ethnic group studies. For instance, Chinese had higher short-term mortality, compared with South Asian and white patients (11). In our study, even after extensive propensity score matching analysis, in-hospital mortality was not improved between the two time points irrespective of types of AMI and revascularization methods. Rather, in hospital mortality of AMI-HF seems to be higher in 2008 than in 1998 (11.1% vs 6.4%, $P = 0.071$), although it does not reach statistical significance. Higher referral rate from other hospital (41.7% in 2008 vs 36.1% in 1998, $P = 0.111$), higher incidence of shock patients (11.1% in 2008 vs 5.7% in 1998, $P = 0.069$) and higher incidence of previous MI (13.0% in 2008 vs 3.1% in 1998, $P < 0.001$) might contribute to this finding. However, nationwide large prospective study with non-selected AMI patients would clarify the actual temporal trends of in-hospital mortality. In addition, future studies about the trends of HF following AMI in Asian region might be followed to confirm the disparities between western and East-Asian patients.

The studies to decipher the predictors for HF in AMI have been conducted. Najafi et al. (4) showed that age, current smoker, hypertension, diabetes, Q-wave and anterior wall MI were independent predictors of early-onset HF after MI. Ezekowitz et al. (10) reported that male gender, hypertension, diabetes, atrial fibrillation and CVA were associated with the risk for developing HF during hospitalization in MI. In HORIZONS-AMI trial, multivariate predictors of new-onset HF following PCI in STEMI were history of MI, LVEF, female and insulin-treated di-

Table 4. Independent predictors for AMI with HF in 1998 and 2008 respectively

Parameters	1998			2008		
	OR	95% CI	*P* value	OR	95% CI	*P* value
Age (yr)	1.023	1.008-1.038	0.003	1.029	1.016-1.043	< 0.001
Transfer from other hospital	1.668	1.132-2.459	0.010	1.696	1.216-2.364	0.002
Chest pain	0.693	0.259-1.859	0.467	0.439	1.216-2.364	0.002
Systolic blood pressure (mmHg)	0.997	0.991-1.003	0.381	0.988	0.982-0.994	< 0.001
Heart rate	1.023	1.008-1.038	0.003	1.019	1.010-1.028	< 0.001
Anteroseptal infarction	1.564	1.089-2.246	0.015	1.335	0.961-1.856	0.085

AMI, acute myocardial infarction; HF, heart failure; OR, odds ratio; CI, confidence interval.

Table 5. Comparison of baseline characteristics of AMI with HF in 1998 and 2008

Characteristics	1998 (n = 228)	2008 (n = 324)	*P* value
Demographics			
Male gender, No. (%)	157 (68.9)	232 (71.6)	0.486
Age (yr)	62.0 ± 13.1	65.0 ± 12.8	0.010
STEMI, No. (%)	159 (69.7)	204 (63.0)	0.120
Vital sign			
Systolic blood pressure (mmHg)	128.0 ± 29.9	120.7 ± 31.4	0.006
Diastolic blood pressure (mmHg)	78.0 ± 19.0	72.5 ± 18.5	0.001
Heart rate (/min)	83.8 ± 21.1	83.2 ± 23.1	0.770
Shock, No. (%)	13 (5.7)	36 (11.1)	0.067
Diagnostic criteria of HF			
LVEF < 40%, No. (%)	84 (45.9)	155 (56.0)	0.035
Congestion on radiograph, No. (%)	191 (90.1)	270 (83.9)	0.040
Adjuvant Therapy, No. (%)			
Ventilator	23 (11.2)	89 (30.9)	< 0.001
IABP	20 (9.8)	57 (19.8)	0.002
ECMO	0 (0.0)	10 (3.5)	0.006
Inotropics	43 (21.0)	124 (43.1)	< 0.001
Gp IIb/IIIa inhibitor	62 (30.2)	89 (30.9)	0.876
Medical history, No. (%)			
Diabetes mellitus	71 (31.1)	107 (33.2)	0.606
Hypertension	95 (41.9)	175 (54.0)	0.005
Dyslipidemia	32 (14.3)	58 (18.0)	0.264
Smoking	124 (54.9)	164 (50.8)	0.345
CVA	19 (8.4)	28 (8.6)	0.910
Previous MI	7 (3.1)	42 (13.0)	< 0.001
Familial history, No. (%)	33 (14.7)	47 (15.0)	0.927
Discharge medication, No. (%)			
Aspirin	170 (86.3)	242 (86.1)	0.957
Clopidogrel	0 (0.0)	224 (79.4)	< 0.001
Ticlopidine	65 (33.0)	3 (1.1)	< 0.001
Cilostazole	5 (2.6)	30 (10.6)	0.001
Beta-blocker	83 (42.1)	156 (55.3)	0.005
ACEI	101 (51.3)	117 (41.8)	0.041
ARB	4 (2.0)	52 (18.5)	< 0.001
CCB	58 (29.4)	52 (18.4)	0.005
Digoxin	23 (11.7)	10 (3.5)	0.001
Aldosterone antagonist	6 (3.0)	63 (22.3)	< 0.001
Other diuretics	56 (28.4)	75 (26.6)	0.658
Statin	33 (16.8)	207 (73.4)	< 0.001
Other lipid lowering agent	2 (1.0)	6 (2.1)	0.353
ACEI/ARB+Beta-blocker	45 (23.0)	107 (38.1)	< 0.001
Number of anti-platelet, No. (%)			
0	24 (12.3)	34 (12.1)	< 0.001
1	103 (52.8)	26 (9.3)	
2	68 (34.9)	194 (69.3)	
3	0 (0)	26 (9.3)	
Echocardiogram, No. (%)	189 (82.9)	277 (85.5)	0.407
LVEF (%)	41.4 ± 12.3	39.6 ± 13.0	0.129
Admission duration (day)	14.71 ± 18.68	11.69 ± 13.44	0.037
ICU care duration (day)	7.05 ± 9.79	5.82 ± 8.54	0.139
In-hospital death, No. (%)	13 (6.4)	32 (11.1)	0.071

AMI, acute myocardial infarction; HF, heart failure; STEMI, ST elevation MI; LVEF, left ventricular ejection fraction; IABP, intra-aortic balloon pump; ECMO, extracorporeal membrane oxygenation; Gp, glycoprotein; CVA, cerebrovascular accident; MI, myocardial infarction; ACEI, angiotension converting enzyme inhibitor; ARB, angiotensin II receptor blocker; CCB, calcium channel blocker; ICU, intensive care unit.

abetes (14). In one study in Korea, old age, female gender, high serum creatinine and low LVEF were the predictors for long-term mortality in acute coronary syndrome patients with left ventricular systolic dysfunction (15). In consistent with these findings, we could find many HF risk factors in multivariate analysis (Table 3). Most of them were related to hemodynamic status (lower systolic blood pressure, increased heart rate) and co-morbid medical conditions (e.g. hypertension, diabetes, and CVA). AMI patients with HF in 2008 were older and, had a higher prevalence of hypertension, previous AMI, adjuvant therapy and lower systolic blood pressure than those in 1998. Considering these lines of findings, older age, transfer from other hospital, and lower systolic blood pressure at admission were important risk factors for HF development following AMI in Korea. Therefore more attentions and early treatments about concomitant HF should be paid in AMI patients with low systolic blood pressure and underlying medical diseases.

This study has several limitations. First, although we sought to analyze all consecutive AMI patients at two time periods, selection of patients was dependent on ICD codes of medical database without detailed clinical information such as laboratory and angiographic findings. Even though utilizing an administrative database with established quality control, the absence of validation of diagnosis and subsequent coding might be an important limitation. Though we excluded patients with underlying heart failure, there are possibilities that patient with asymptomatic LV dysfunction with no apparent heart failure symptom (NYHA II) could be enrolled as a patient with HF complicated AMI in this study. Second, because the data pertain only to one city and two times of year, this result may not be applicable to other nationwide patients. Third, the lack of long-term follow up data after discharge might underestimate overall HF incidence rates and prevent further analysis with long-term mortality of AMI-HF. Lastly but most importantly, we could not analyze the long-term outcome of AMI-HF patients. Therefore further prospective studies are required to reveal whether recent development of procedural managements and more evidence-based practice might improve midterm as well as long term survival after index admission of AMI-HF patients.

In conclusion, more evidence-based medical and advanced procedural managements were applied with patients with AMI in 2008 than in 1998, but there were no significant differences in the incidence of HF during hospitalization and in-hospital mortality following AMI between 1998 and 2008 in Korea.

DISCLOSURE

The authors declare no conflicts of interest.

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Supplementary Table 1. Propensity score matching analysis for in-hospital mortality in AMI patients with HF between 1998 and 2008

Variables	1998 (n = 128)	2008 (n = 128)	*P* value
Gender			
Male	88 (68.75)	90 (70.31)	0.763
Female	40 (31.25)	38 (29.69)	
Age (yr)	62.37 ± 12.54	62.73 ± 12.94	0.791
STEMI, No. (%)			
Yes	88 (68.75)	91 (71.09)	0.662
No	40 (31.25)	37 (28.91)	
Hypertension			
Yes	54 (42.19)	58 (45.31)	0.617
No	74 (57.81)	70 (54.69)	
Diabetes mellitus			
Yes	41 (32.03)	42 (32.81)	0.898
No	87 (67.97)	86 (67.19)	
CVA			
Yes	11 (8.59)	11 (8.59)	> 0.999
No	117 (91.41)	117 (91.41)	
Previous MI			
Yes	3 (2.34)	2 (1.56)	> 0.999
No	125 (97.66)	126 (98.44)	
Dyslipidemia			
Yes	20 (15.63)	19 (14.84)	> 0.999
No	108 (84.38)	109 (85.16)	
Smoking			
Yes	63 (49.22)	64 (50.00)	0.891
No	65 (50.78)	64 (50.00)	
Family history			
Yes	18 (14.06)	21 (16.41)	0.728
No	110 (85.94)	107 (83.59)	
SBP (mmHg)	124.47 ± 27.72	127.43 ± 29.73	0.426
Heart rate (/min)	82.31 ± 20.43	82.70 ± 20.56	0.877
PCI			
Yes	79 (61.72)	82 (64.06)	0.668
No	49 (38.28)	46 (35.94)	
CABG			
Yes	13 (10.16)	13 (10.16)	> 0.999
No	115 (89.84)	115 (89.84)	
Ventilator			
Yes	19 (14.84)	18 (14.06)	> 0.999
No	109 (85.16)	110 (85.94)	
IABP			
Yes	15 (11.72)	17 (13.28)	0.845
No	113 (88.28)	111 (86.72)	
Inotropics			
Yes	33 (25.78)	33 (25.78)	> 0.999
No	95 (74.22)	95 (74.22)	
ICU care duration (day)	6.13 ± 8.14	6.07 ± 10.84	0.960
In-hospital mortality, No. (%)			
Yes	6 (4.69)	11 (8.59)	0.332
No	122 (95.31)	117 (91.41)	

AMI, acute myocardial infarction; HF, heart failure; STEMI, ST elevation MI; CVA, cerebrovascular accident; MI, myocardial infarction; SBP, systolic blood pressure; PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft; IABP, intra-aortic balloon pump; ICU, intensive care unit.

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Supplementary Table 2. Propensity score matching analysis for in-hospital mortality in AMI patients with HF treated by PCI between 1998 and 2008

Variables	1998 (n = 71)	2008 (n = 71)	*P* value
Gender			
Male	51 (71.83)	51 (71.83)	> 0.999
Female	20 (28.17)	20 (28.17)	
Age (yr)	60.23 ± 12.60	59.79 ± 12.87	0.813
STEMI, No. (%)			
Yes	57 (80.28)	56 (78.87)	> 0.999
No	14 (19.72)	15 (21.13)	
Hypertension			
Yes	29 (40.85)	33 (46.48)	0.505
No	42 (59.15)	38 (53.52)	
Diabetes mellitus			
Yes	21 (29.58)	25 (35.21)	0.346
No	50 (70.42)	46 (64.79)	
CVA			
Yes	5 (7.04)	2 (2.82)	0.453
No	66 (92.96)	69 (97.18)	
Previous MI			
Yes	0 (0.00)	0 (0.00)	> 0.999
No	71 (100.00)	71 (100.00)	
Dyslipidemia			
Yes	13 (18.31)	11 (15.49)	0.839
No	58 (81.69)	60 (84.51)	
Smoking			
Yes	36 (50.70)	35 (49.30)	0.866
No	35 (49.30)	36 (50.70)	
Family history			
Yes	12 (16.90)	10 (14.08)	0.832
No	59 (83.10)	61 (85.92)	
SBP (mmHg)	126.54 ± 25.36	125.30 ± 29.36	0.790
Heart rate (/min)	81.72 ± 18.63	80.44 ± 20.40	0.680
Ventilator			
Yes	2 (2.82)	4 (5.63)	0.500
No	69 (97.18)	67 (94.37)	
IABP			
Yes	9 (12.68)	8 (11.27)	> 0.999
No	62 (87.32)	63 (88.73)	
Inotropics			
Yes	14 (19.72)	16 (22.54)	0.832
No	57 (80.28)	55 (77.46)	
ICU care duration (day)	4.11 ± 2.88	4.77 ± 9.31	0.567
In-hospital mortality, No. (%)			
Yes	1 (1.41)	3 (4.23)	0.500
No	70 (98.59)	68 (95.77)	

AMI, acute myocardial infarction; HF, heart failure; PCI, percutaneous coronary intervention; STEMI, ST elevation MI; CVA, cerebrovascular accident; MI, myocardial infarction; SBP, systolic blood pressure; IABP, intra-aortic balloon pump; ICU, intensive care unit.

Supplementary Table 3. Propensity score matching analysis for in-hospital mortality in patients with STEMI with HF treated with PCI between 1998 and 2008

Variables	1998 (n = 38)	2008 (n = 38)	*P* value
Gender			
Male	28 (73.68)	28 (73.68)	> 0.999
Female	10 (26.32)	10 (26.32)	
Age (yr)	61.29 ± 11.52	61.29 ± 13.64	> 0.999
Hypertension			
Yes	15 (39.47)	16 (42.11)	0.808
No	23 (60.53)	22 (57.89)	
Diabetes mellitus			
Yes	7 (18.42)	10 (26.32)	0.607
No	31 (81.58)	28 (73.68)	
CVA			
Yes	3 (7.89)	3 (7.89)	> 0.999
No	35 (92.11)	35 (92.11)	
Previous MI			
Yes	0 (0.00)	0 (0.00)	> 0.999
No	38 (100.00)	38 (100.00)	
Dyslipidemia			
Yes	5 (13.16)	4 (10.53)	> 0.999
No	33 (86.84)	34 (89.47)	
Smoking			
Yes	24 (63.16)	25 (65.79)	> 0.999
No	14 (36.84)	13 (34.21)	
Family history			
Yes	6 (15.79)	7 (18.42)	> 0.999
No	32 (84.21)	31 (18.58)	
SBP (mmHg)	126.95 ± 29.39	120.18 ± 27.37	0.286
Heart rate (/min)	80.03 ± 20.26	81.05 ± 25.46	0.842
Ventilator			
Yes	6 (15.79)	5 (13.16)	> 0.999
No	32 (84.21)	33 (86.84)	
IABP			
Yes	8 (21.05)	8 (21.05)	> 0.999
No	30 (78.95)	30 (78.95)	
Inotropics			
Yes	11 (28.95)	14 (36.84)	0.549
No	27 (71.05)	24 (63.16)	
ICU care duration (day)	4.74 ± 3.77	4.32 ± 5.17	0.711
In-hospital mortality, No. (%)			
Yes	2 (5.26)	3 (7.89)	> 0.999
No	36 (94.74)	35 (92.11)	

STEMI, ST elevation MI; HF, heart failure; PCI, percutaneous coronary intervention; CVA, cerebrovascular accident; MI, myocardial infarction; SBP, systolic blood pressure; IABP, intra-aortic balloon pump; ICU, intensive care unit.

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