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In-depth Single-Center Retrospective Assessment of In-Hospital Outcomes in Acute Myocardial Infarction Patients with and without Diabetes

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Abstract

Objective This study examined variations in in-hospital mortality causes and identified independent mortality predictors among acute myocardial infarction (AMI) patients with and without diabetes mellitus (DM).

Methods We examined the factors influencing in-hospital mortality in a single-center, retrospective observational study. Separate multivariate analyses were conducted for both groups to identify independent predictors of in-hospital death.

Patients The study included consecutive patients admitted to Iwate Medical University Hospital from January 2012 to December 2017 with a diagnosis of AMI.

Results Out of 1140 patients meeting the AMI criteria (average age: 68.2 ± 12.8 years, 75% male), 408 (35.8%) had diabetes. The DM group had a 1.87 times higher 30-day mortality rate, a lower prevalence of ST-elevated MI (56.6% vs. 65.3% in non-DM, p=0.004), and more frequent non-cardiac causes of death (32% vs. 14% in non-DM, p=0.046). Independent predictors for in-hospital mortality in both groups were cardiogenic shock (CS) (DM: HR 6.59, 95%CI 2.90-14.95; non-DM: HR 4.42, 95%CI 1.99-9.77) and renal dysfunction (DM: HR 5.64, 95%CI 1.59-20.04; non-DM: HR 5.92, 95%CI 1.79-19.53). Among patients with diabetes, a history of stroke was an additional independent predictor (HR 2.59, 95%CI 1.07-6.31).

Conclusion Notable disparities were identified in the causes of death and predictive factors for mortality among the two groups of AMI patients. For further improvement of AMI outcomes, individualized management and prioritizing non-cardiac comorbidities during hospitalization may be crucial, particularly in patients with diabetes.

Key words: diabetes mellitus, acute myocardial infarction, cause of death, mortality

Introduction

Diabetes mellitus (DM) is widely recognized as being associated with worse clinical scenarios across various facets of ischemic heart disease. Indeed, it is a significant coronary risk factor. Moreover, the atherosclerotic changes in coronary arteries tend to exhibit a more extensive distribution in individuals with diabetes. Following revascularization, a higher occurrence of restenosis or major adverse clinical events can be expected in patients with diabetes during follow-up periods. In addition, even drug-eluting stents are employed (1).

Acute myocardial infarction (AMI) has remained a significant contributor to mortality worldwide. Based on an observational multicenter registry in Japan, 36.4% of AMI patients were found to have DM comorbidity (2).

With the widespread adaption of primary coronary intervention (PCI), AMI mortality has declined substantially. The current nationwide registry database in Japan has indicated that the mortality rate could be reduced to less than 3% if AMI patients receive primary PCI (3). However, a German study that compared outcomes between 2005 and 2021 highlighted how the rates of in-hospital death remained statistically higher in MI patients with DM compared with those without DM, despite an overall reduction in in-hospital mortality (4). Even with the contemporary

utilization of primary PCI, patients with DM still experience higher in-hospital mortality (5), and the long-term prognosis has also been observed to be worse within this population (6).

While the overall association between AMI and DM has been confirmed, comprehensive evaluation is lacking, including a precise determination of the direct cause of death. Accordingly, the present study was undertaken to elucidate specific variations in the direct causes of in-hospital mortality between patients with and without DM to explore the independent factors that predict mortality, considering each patient group separately.

This study aims to provide a more comprehensive understanding of the differences in the causes of death associated with AMI in patients with and without DM, as well as to identify distinct predictors of mortality within these two patient groups.

Methods

Study population

The study population comprises patients who were admitted to Iwate Medical University Hospital between January 2012 and December 2017 due to AMI, specifically those who meet the criteria outlined in the 3rd universal definition of myocardial infarction (MI) (7).

AMI was diagnosed following evidence of myocardial necrosis in acute myocardial ischemia patients in a clinical setting. The criteria for detection include the presence of a rise and/or fall in cardiac biomarker values, with at least one value exceeding the 99th percentile upper reference limit. Additionally, any one of the following conditions had to be met: 1) symptoms of ischemia, 2) new or presumed new significant ST-segment-T wave changes or new left bundle branch block, 3) development of pathological Q wave in the electrocardiogram (ECG), 4) imaging evidence of new loss of viable myocardium or new regional wall motion abnormality, and 5) identification of an intracoronary thrombus by angiography or autopsy. Furthermore, in accordance with the universal classification of MI (type 1 to 5), as defined by 3rd universal definition (7), the patients needed to be classified as either type 1: spontaneous MI; type 2: MI secondary to an ischemia imbalance; or MI resulting in death when biomarker values area unavailable.

Exclusion criteria for the study subjects included: 1) patients with AMI classified into two categories—type 4, which includes MI related to PCI or stent thrombosis, and type 5, which encompasses MI related to coronary artery bypass grafting; 2) patients transported after an unexplained cardiac arrest who, without resuscitation or admission, died, making it unclear whether myocardial ischemia was involved; and 3) patients who declined participation in the study via an opt-out mechanism.

The study was conducted in accordance with the ethical provisions of the Helsinki Declaration (2013 Brazil revision), and it received approval from the Ethics Committee at Iwate Medical University (MH2023-013). As a retrospective observational study, an opportunity to opt-out was provided to eligible patients (https://iwate-heart.jp/public_information/).

Definition

The definition of each parameter used in this study was established by referring to previous studies widely regarded as representative in the field. Hypertension was defined (in accordance with the ACC/AHA Stage 2 hypertension guidelines) as a systolic blood pressure of 140 mmHg or higher, a diastolic blood pressure of 90 mmHg or higher upon admission, or the use of antihypertensive medication (8). Diabetes was defined as either a blood sugar level of 200 mg/dL or higher upon admission, an HbA1c of 6.5% or higher, or the administration of diabetes medication (9). For cases not meeting this definition, fasting blood sugar, daily blood sugar fluctuation, and glucose tolerance tests were not conducted. Dyslipidemia was defined in line with the guidelines in Japan as LDL cholesterol of 140 mg/dL or higher or HDL cholesterol less than 40 mg/dL (10), and included total cholesterol of 240 mg/dL or higher or the administration of lipid-lowering drugs. A history of ischemic heart disease was defined as a past instance of AMI or revascularization (either PCI or CABG (coronary artery bypass grafting)). Current smoking

history was defined as smoking within a year prior to admission. A history of stroke was defined as any past stroke that required hospitalization, including both cerebral infarction or intracranial hemorrhage. Consequently, incidental asymptomatic lacunar infarctions identified on imaging were not included. Atrial fibrillation was defined as any history of treatment, regardless of whether it was chronic or paroxysmal, or any evidence of atrial fibrillation found on previous Holter monitoring or a 12-lead ECG. Cases of paroxysmal atrial fibrillation observed transiently during hospitalization without a previous record were not included. However, those with consistent atrial fibrillation waveforms upon admission, even without a prior record, were included. Obesity was defined as a body mass index (BMI) of 25.0 kg/m^2 or higher upon admission (11). Renal dysfunction was defined as an estimated GFR of less than 60 $mL/min/1.73m^2$ upon admission (12) or dialysis.

Study endpoints

The primary outcome measure of the study was in-hospital mortality, and a thorough examination of the underlying causes of death was conducted. Secondary outcome measures included acute-phase complications occurring during hospitalization, such as heart failure, shock, arrhythmias, bleeding, mechanical complications, and infections.

Statistical analyses

All statistical analyses were conducted using SPSS® 28.0 for Windows (IBM, Chicago, USA). The patients were divided into two groups based on the presence or absence of diabetes, and analyses were conducted accordingly. For comparisons between the two groups, the Chi-squared and Mann–Whitney U tests were employed. To calculate the cumulative event occurrence rate, the Kaplan–Meier method was used. The hazard ratio for event occurrence was assessed using Cox's proportional hazards model. A significance level of $p<0.05$ was considered statistically significant.

Results

Patient and clinical characteristics

A total of 1140 AMI patients met the enrollment criteria, and 408 patients (35.8%) were categorized as having DM. The mean age of the patients was 68.2±12.8 years and 75% were male. The subjects were stratified into two groups based on the presence of DM. Table 1 shows a comparison of baseline clinical characteristics between the DM and non-DM groups. The DM group exhibited a statistically significantly larger BMI and a higher prevalence of hyperlipidemia. In contrast, current smoking and hypertension were significantly more prevalent in the non-DM group. Regarding a previous history of major vascular diseases, a history of coronary artery

disease or stroke was significantly more frequent in the DM groups. Importantly, the frequency of cardiac arrest on admission was significantly higher in the DM group, despite no apparent changes being observed in systolic and diastolic blood pressure values on admission between the two groups.

The prevalence of ST-elevated MI was significantly lower in the DM group. Significant differences were observed between the two groups in terms of ejection fraction on admission, serum creatinine level and estimated glomerular filtration rate (eGFR), serum B-type natriuretic peptide (BNP) level, and Killip status. Blood examination of serum lipid profiles revealed a significantly higher triglyceride level and a significantly lower LDL-cholesterol level in the DM group.

Patient management and overall in-hospital outcomes

A detailed comparison of patient management is shown in Table 2. In the DM group, emergent coronary angiography and emergent PCI were performed significantly less frequently. Additionally, the prevalence of lesions involving the left main coronary artery was significantly higher in the DM group. Moreover, patients in the DM group underwent CABG significantly more frequently.

Regarding mechanical support, it was observed that patients in the DM group received significantly more frequent treatments with a mechanical ventilator, intra-aortic balloon pump, and VA-Extracorporeal Membrane Oxygenation (ECMO). As a result, in-hospital mortality was significantly higher and the length of hospital stay was significantly longer in the DM group. The Kaplan–Meier survival curve of in-hospital mortality (within 30 days after admission) illustrated in Figure 1 shows a significant difference between the two groups. The hazard ratio for in-hospital mortality in the DM group was 1.87 (95%CI: 1.19–2.93, p=0.007).

In-depth analysis of the causes of in-hospital deaths and predictive factors

The rate of in-hospital mortality among the 1140 patients included in this study was 6.6%. A comparison of the causes of in-hospital death between the two groups is illustrated in Figure 2. Nearly half of the causes were attributed to cardiogenic shock (CS) in both groups. However, the remaining causes of death appeared to differ between the two groups, particularly in terms of mechanical complications, infection, and malignant disease. When comparing the causes of death, a higher proportion of non-cardiac deaths (including infections, malignancies, strokes, and multiple organ failures) were observed in the DM group compared to the non-DM group (32% vs. 14%, P=0.046, respectively). Deaths due to mechanical complications were numerically more frequent in the non-DM group, but the difference was not statistically significant (DM: 16% vs

non-DM: 32%, p=0.119). When examining the relationship between the timing of death and its causes, it was found that for both groups, the majority of deaths up until the third clinical day were predominantly due to cardiogenic shock or mechanical complications. However, regarding the causes of death after the tenth clinical day, in the DM group, the proportion of deaths attributed to cardiogenic shock or mechanical complications was less than 30%, with a greater number of patients dying from other causes such as lethal arrhythmias, cerebral infarction, infections, and malignancies. In contrast, in the non-DM group, the proportion due to cardiogenic shock or mechanical complications remained high at 65%.

Factors potentially associated with in-hospital mortality were individually compared between those who survived and those who died in both the DM and non-DM groups, as shown in Table 3. In the DM group, statistically significant differences were observed in age, hypertension, current smoking, history of stroke, Killip status, ejection fraction on admission, renal dysfunction (eGFR<60), and serum BNP level between the survival and in-hospital death subgroups. Conversely, these factors showed slight variations in the non-DM group. Interestingly, sex, history of atrial fibrillation, and ST elevation were also found to be statistically different factors in the non-DM group. Notably, in the non-DM group, a history of stroke no longer had a significant impact on in-hospital death when comparing survival and deceased patients.

The predictors of in-hospital mortality for both the DM and non-DM groups were separately

analyzed using univariate analyses, and the results are shown in Table 4. Subsequently, any factors found to be statistically significant in the univariate analyses in either group were included in Cox's proportional hazards model to identify independent predictors of in-hospital death, as shown in Table 5. Consequently, CS, renal dysfunction, and a history of stroke independently predicted in-hospital mortality in the DM group. Conversely, CS and renal dysfunction were identified as independent predictors of in-hospital mortality in the non-DM group. In the non-DM group, patients who underwent revascularization (emergency PCI or CABG) procedures had a lower risk of in-hospital mortality, but this difference was not statistically significant in the DM group. Interaction test for in-hospital death using a two-way analysis of variance (ANOVA) shows that there was an interaction between “diabetes mellitus” and “history of stroke” (p = 0.006).

In addition, we focused on patients suffering from CS (n=97) and compared in-hospital mortality between those with DM (n=47) and those without DM (n=50) under these conditions. In-hospital deaths were observed in 23 CS cases in the DM group (48.9%) and in 19 cases in the non-DM group (38.0%). The DM group had a numerically higher mortality rate; however, these differences were not statistically significant (p=0.277).

Discussion

The results of this study can be summarized as follows. 1) The dominant coronary risk factors, or the proportion of these risk factors, varied between individuals with DM and those without DM. 2) In the DM group, a higher prevalence of non-ST elevation MI was observed. 3) Among patients who had AMI, those with diabetes had a worse short-term prognosis compared to those without diabetes. The risk of mortality within 30 days after experiencing an AMI was 1.87 times higher in the DM group. 4) There were distinct differences in the direct causes of mortality between the two groups. Non-cardiac causes were more prevalent in DM patients, despite CS being a significant factor in almost half of the cases in both groups. 5) The presence of CS on admission and renal dysfunction were identified as independent risk factors for in-hospital mortality in both groups. Moreover, among patients with diabetes, a history of stroke was also recognized as an independent factor that could worsen the in-hospital prognosis. The impact of revascularization procedures on in-hospital mortality differed between the DM and non-DM groups. 6) There was no significant difference observed in in-hospital mortality among patients with CS between the DM and non-DM groups.

In Japan, there is a limited amount of research regarding predictors of in-hospital mortality for AMI based on the presence or absence of diabetes as well as differences in the specific causes of death. Although we have conducted large-scale studies, such as the JROAD registry (13) and the

J-PCI Registry (3) related to AMI in Japan, these registry surveys are limited in terms of available parameters, and it is speculated that they may not be suitable for in-depth research analysis.

In contrast, our institution (Iwate Medical University) maintains a detailed database of AMI patients that adheres to the latest definitions, encompassing registrations for over 1000 individuals. With access to medical records, we can conduct comprehensive retrospective investigations. Utilizing this database, we have the potential to explore predictors of in-hospital mortality for AMI patients based on their diabetes status, delve into the specific causes of death, and thoroughly examine other related factors.

In terms of differences in clinical presentation, there is a relatively higher prevalence of non-ST elevation myocardial infarction (NSTEMI) in the DM group. This may be attributed, to some extent, to the presence of pre-existing collateral circulation due to advanced plaque progression in this population.

While previous studies have documented an adverse prognosis in AMI patients with comorbid diabetes mellitus (5,14,15), our study adds clarity by demonstrating a substantial impact on mortality. Notably, we identified a hazard ratio of 1.87 for mortality, even in a cohort in which nearly 85% of patients underwent invasive strategies. When considering cardiovascular deaths (which included CS, mechanical complications, and lethal arrhythmias), these events accounted for nearly 85% of in-hospital fatalities in the non-DM group. Conversely, they constituted only

68% of in-hospital deaths in the DM group, thus signifying a higher prevalence of non-cardiovascular causes of mortality in this population. Infections, strokes, and malignancies have emerged as the direct causes of death in this subgroup. Considering the systemic nature of disorders in patients with diabetes, these results are not surprising, but they underscore the importance of comprehensive care or systemic management for this population in order to further improve survival rates.

The higher prevalence of stroke as the direct cause of death in the DM group can be explained as follows. Patients with diabetes typically exhibit a higher prevalence of diseased aortic walls or a prothrombotic state, as well as an increased need for mechanical cardiac support during the perioperative period. These additional factors may increase rates of embolic stroke, which can be induced by catheterization procedures or mechanical support devices, as well as by thrombi within the aneurysmal left ventricle. Furthermore, the greater requirement for anticoagulant agents to address these problems may be associated with an elevated risk of hemorrhagic stroke.

In the DM group, we observed a higher prevalence of advanced Killip status upon admission, along with a greater frequency of mechanical cardiac support devices. Consequently, the patient's condition tended to deteriorate further since the time of admission when compared to the non-DM groups. Nevertheless, the DM group exhibited lower actual rates of both coronary angiography and revascularization when compared to the non-DM group, similar to a previous

report (16). The lower frequency of ST-elevation MI, the possibility of a higher occurrence of asymptomatic patients, and concerns related to impaired renal function and the use of contrast agent, may partially explain the lower rate of emergent angiography. The higher frequency of left main coronary artery involvement in the DM group led to a reduced use of PCI and an increased use of CABG. These factors are hypothesized to not only influence the lower frequency of revascularization procedures but also to explain the divergent prognostic outcomes of these procedures between the DM and non-DM groups.

CS continues to be a significant factor influencing mortality in patients with AMI, as supported by numerous previous studies (17–19). However, our findings revealed that there was no difference in in-hospital mortality between diabetic patients with CS and non-diabetic patients with CS, consistent with a previous study report (20). Because the management of CS remains a paramount concern in both groups, alternative approaches, such as the utilization of left ventricle unloading devices (21) (22) or intracoronary super-saturated oxygen therapy (23), may be further explored to enhance the outcomes of patients experiencing CS.

While both groups shared common predictors of in-hospital mortality, such as CS and renal dysfunction, a history of stroke was identified as an independent predictor of in-hospital mortality solely within the DM group. The reasons cannot be explained easily. One possible explanation could be that systemic atherosclerosis is more advanced in patients with diabetes. Another

potential explanation could be that patients with a history of stroke may be frailer than those without such a history. We currently estimate such mechanisms underlying these results. However, it is essential to pay careful attention to AMI patients with such a history throughout their hospitalization, especially among patients with diabetes.

Study limitations

In this study, diabetes was defined according to criteria established from prior AMI research and existing literature. Intraday glucose variability and oral glucose tolerance tests were not performed, potentially leading to some cases of diabetes or impaired glucose tolerance being categorized as non-diabetic. This limitation is inherent in the study. Furthermore, despite the availability of the latest 4th version of the universal definition (24), we chose to apply the 3rd version of the universal definition (7) in this study. This decision was made because the 3rd definition was in use during the recruitment period for this study. However, it is important to acknowledge that the composition of the enrolled patient population may not have substantially differed had we employed the 4th universal definition (25).

Finally, door-to-balloon time is a well-established mortality parameter in AMI patients (26). However, our study had a substantial proportion of NSTEMI patients (about 40%), so we did not include this parameter in our analysis.

Conclusion

In patients with AMI, the 30-day mortality rate was 1.87 times higher in the DM group. DM patients had a higher occurrence of non-cardiac causes of death, with CS being responsible for almost half of the mortality cases in both groups. Independent predictors for in-hospital mortality were CS and renal dysfunction in both patient groups, while a history of stroke was identified as an additional predictor in the DM group. To further improve outcomes for AMI patients, personalized management that prioritizes addressing non-cardiac comorbidities during hospitalization may be crucial, particularly in patients with diabetes.

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COI

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Figure legends

Figure 1. Thirty-day cumulative survival rates in patients with acute myocardial infarction, stratified by diabetes status. Patients with diabetes (shown in red) demonstrated a significantly lower survival rate compared to those without diabetes (shown in blue).

Figure 2. Pie charts illustrating the causes of death in each group reveal differences. In the DM group, a higher percentage of non-cardiac deaths, such as infections, malignancies, strokes, and multiple organ failures, was observed compared to the non-DM group (32% vs. 14%, respectively), with a statistically significant difference (P=0.046). Among the 6 cases of mechanical complications in patients who died in the DM group, there were 2 cases of ventricular septal rupture (VSR) and 4 cases of free-wall rupture (FWR). In the non-DM group, out of the 12 cases of mechanical complications in deceased patients, there were 4 cases of VSR, 7 of FMR, and 1 of papillary muscle rupture (PMR).

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Table 1. A comparison of baseline clinical characteristics between the DM or non-DM groups

Variables	Total (n=1140)	DM (n=408)	Non-DM (n=732)	*P* value
Age (years)	68.2±12.8	68.3±12.1	68.0±13.1	0.977
Sex (Male)	76.0%	74.8%	76.6%	0.475
BMI (kg/m2)	24.4±4.0	25.0±4.2	24.0±3.8	<0.001
Obesity (BMI>=25)	38.1%	45.6%	34.6%	<0.001
DM	35.8%	100%	0	
Hypertension	69.9%	78.7%	64.9%	<0.001
Dyslipidemia	51.3%	62.8%	44.8%	<0.001
Current smoker	34.9%	34.4%	35.2%	0.784
History of CAD	13.5%	21.4%	9.0%	<0.001
History of stroke	11.5%	15.3%	9.4%	0.005
History of atrial fibrillation	7.9%	9.1%	7.2%	0.266
CPA on admission	5.3%	7.2%	4.2%	0.029
Systolic BP on admission (mmHg)	145±34	144±34	145±34	0.517
Diastolic BP on admission (mmHg)	85±21	83±21	86±22	0.027
HR on admission (bpm)	81±19	82±20	81±19	0.105
STEMI	62.2%	56.6%	65.3%	0.004
Killip I-IV (%)	71.6/14.3/5.5/8.6	64.2/16.3/7.9/11.6	75.8/13.1/4.1/6.9	<0.001
LVEF (%)	51.4±19.7	49.6±28.9	52.3±11.6	<0.001
Serum creatinine (mg/dL)	1.24±1.65	1.57±2.12	1.06±1.29	0.008
eGFR (mL/min/1.73m2)	68.0±28.5	64.3±33.0	70.1±25.5	0.003
Renal dysfunction (eGFR < 60)	36.9%	44.4%	32.8%	<0.001
Hemodialysis or CAPD	4.4%	8.1%	2.3%	<0.001
Blood glucose (mg/dL)	163±78	207±97	140±50	<0.001
Hemoglobin A1c (%)	6.1±1.5	7.1±1.5	5.6±0.5	<0.001
Triglyceride (mg/dL)	127±111	138±146	120±84	0.002
Total cholesterol (mg/dL)	186±45	179±49	189±42	<0.001
LDL-cholesterol (mg/dL)	115±37	109±37	119±37	<0.001
HDL-cholesterol (mg/dL)	47±14	45±15	48±14	<0.001
L/H ratio	2.6±1.0	2.5±1.0	2.6±1.0	0.144
Brain natriuretic peptide (pg/mL)	381±800	511±975	308±673	0.001

DM: diabetes mellitus, BMI: body mass index, CAD: coronary artery disease, CPA: cardiopulmonary arrest
BP: blood pressure, HR: heart rate, STEMI: ST elevation myocardial infarction, LVEF: left ventricular ejection fraction
eGFR: estimated glomerular filtration rate, CAPD: continuous ambulatory peritoneal dialysis
LDL: low density lipoprotein, HDL: high density lipoprotein

Table 2. A comparison of patient management between the two groups

Variables	Total (n=1140)	DM (n=408)	Non-DM (n=732)	*P* value
Emergency coronary angiography	87.8%	84.2%	89.7%	0.007
Lesion of left main trunk	9.7%	13.9%	7.3%	0.001
Multivessel coronary artery disease	59.6%	71.4%	53.0%	<0.001
Emergency PCI	78.4%	73.8%	81.0%	0.004
Slow-flow or No-reflow post PCI	14.2%	16.1%	13.1%	0.203
Coronary artery bypass grafting	9.2%	12.3%	7.5%	0.008
Respirator	10.5%	14.2%	8.5%	0.004
Intra-aortic balloon pumping	11.4%	16.7%	8.4%	<0.001
VA-ECMO	2.0%	3.3%	1.3%	0.023
Peak creatine kinase (IU/L)	2198±2758	2073±2850	2269±2705	0.003
Hospitalization days	19±48	20±22	18±57	0.002
In-hospital mortality	6.6%	9.3%	5.1%	0.005

DM: diabetes mellitus, PCI: percutaneous coronary intervention, VA-ECMO: venoarterial extracorporeal membrane oxygenation

Table 3. Comparisons of clinical characteristics between AMI patients who survived and those who died from both the DM and non-DM groups

Variables	DM (n=408)			Non-DM (n=732)		
	Survivors (n=370)	In-hospital death (n=38)	*P* value	Survivors (n=695)	In-hospital death (n=37)	*P* value
Age (years)	67.9±12.3	72.8±9.6	0.025	67.6±13.0	75.7±12.7	< 0.001
Sex (Male)	74.3%	78.9%	0.532	77.6%	59.5%	0.011
Obesity (BMI >= 25)	46.1%	40.5%	0.520	35.1%	24.2%	0.199
Hypertension	80.3%	63.2%	0.014	64.0%	82.9%	0.022
Dyslipidemia	63.3%	57.9%	0.510	45.1%	40.0%	0.556
Current smoker	35.9%	14.3%	0.020	36.1%	14.3%	0.018
History of CAD	21.9%	16.2%	0.422	8.7%	14.3%	0.263
History of stroke	13.8%	28.6%	0.022	9.7%	3.2%	0.227
History of atrial fibrillation	8.4%	15.8%	0.130	6.1%	27.8%	< 0.001
Cardiogenic shock (Killip IV)	6.5%	62.2%	< 0.001	4.5%	52.8%	< 0.001
STEMI	55.4%	68.4%	0.123	64.2%	86.1%	0.007
LVEF (%)	49.5±12.0	50.8±89.3	< 0.001	52.7±11.4	44.2±13.8	< 0.001
Blood glucose (mg/dL)	200 ± 88	282 ± 149	0.001	128 ± 27	133 ± 47	0.252
Renal dysfunction (eGFR < 60)	40.5%	81.6%	< 0.001	39.6%	84.8%	< 0.001
Brain natriuretic peptide (pg/mL)	463.6±935.3	972.4±1225.5	<0.001	279.8±625.9	834.9±1146.0	< 0.001
Revascularization (Emergency PCI or CABG)	82.7%	73.7%	0.169	86.3%	62.2%	< 0.001
- **Emergency PCI**	74.1%	71.1%	0.689	82.4%	54.1%	< 0.001
- **CABG**	13.2%	2.6%	0.057	7.3%	10.8%	0.435

DM: diabetes mellitus, BMI: body mass index, CAD: coronary artery disease, STEMI:ST elevation myocardial infarction, LVEF: left ventricular ejection fraction, eGFR: estimated glomerular filtration rate, PCI: percutaneous coronary intervention, CABG: coronary artery bypass grafting

Table 4. Univariate analyses for in-hospital death

Variables	DM (n=408)			Non-DM (n=732)		
	HR	95%CI	*P* value	HR	95%CI	*P* value
Age (years)	1.03	(0.99 – 1.06)	0.061	1.05	(1.02 – 1.08)	0.002
Sex (Female)	0.77	(0.35 – 1.69)	0.517	2.10	(1.09 – 4.06)	0.028
Hypertension	0.45	(0.23 – 0.87)	0.017	2.45	(1.02 – 5.91)	0.046
History of stroke	1.90	(0.91 – 3.97)	0.087	0.26	(0.36 – 1.93)	0.263
History of atrial fibrillation	1.90	(0.79 – 4.58)	0.15	4.07	(1.93 – 8.55)	< 0.001
Cardiogenic shock (Killip IV)	8.84	(4.49 – 17.41)	< 0.001	10.82	(5.48 – 21.38)	< 0.001
STEMI	1.79	(0.90 – 3.57)	0.098	2.96	(1.15 – 7.63)	0.025
LVEF (%)	1.00	(0.99 – 1.01)	0.19	0.96	(0.94 – 0.99)	0.002
Renal dysfunction (eGFR < 60)	4.30	(1.89 – 9.86)	< 0.001	11.32	(4.39 – 29.20)	< 0.001
Revascularization (Emergency PCI or CABG)	0.61	(0.30 – 1.25)	0.178	0.23	(0.12 – 0.45)	< 0.001

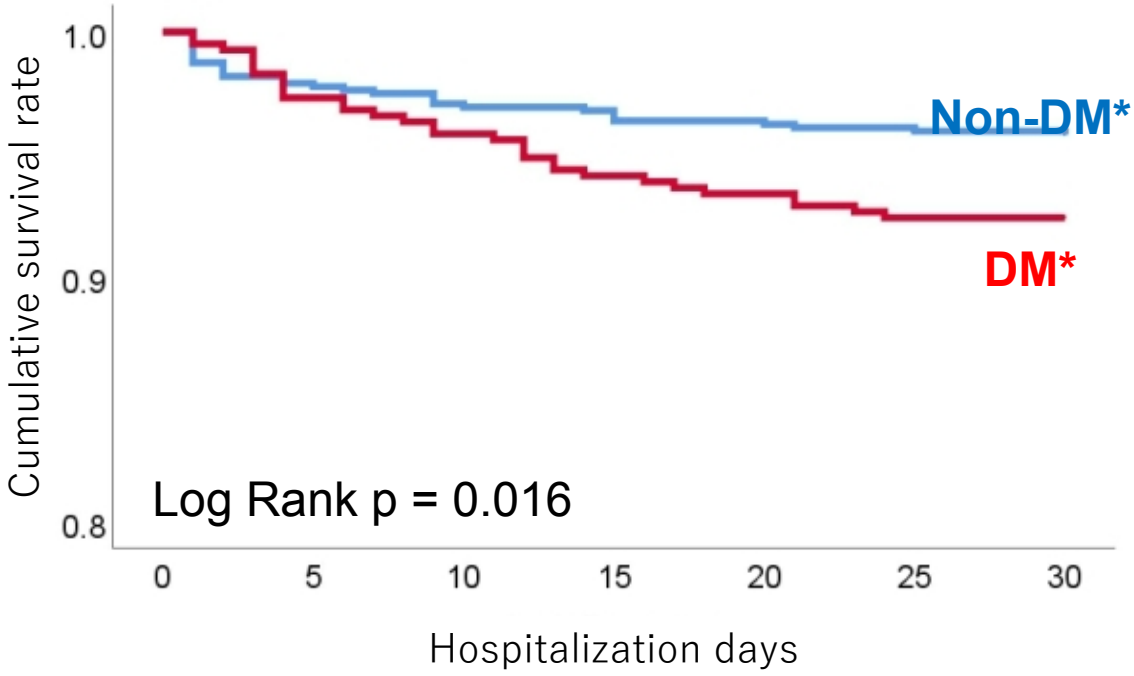
DM: diabetes mellitus, HR: hazard ratio, CI: confidence interval, STEMI: ST elevation myocardial infarction
LVEF: left ventricular ejection fraction, eGFR: estimated glomerular filtration rate
PCI: percutaneous coronary intervention, CABG: coronary artery bypass grafting

Table 5. Multivariate analyses for in-hospital death

Variables	DM (n=408)			Non-DM (n=732)		
	HR	95%CI	*P* value	HR	95%CI	*P* value
Age (years)	0.99	(0.95 – 1.03)	0.497	1.01	(0.96 – 1.04)	0.980
Sex (Female)	0.78	(0.26 – 2.38)	0.668	1.40	(0.63 – 3.01)	0.406
Hypertension	0.81	(0.34 – 1.93)	0.634	1.38	(0.53 – 3.58)	0.506
History of stroke	2.59	(1.07 – 6.31)	0.036	0.34	(0.045 – 2.61)	0.302
History of atrial fibrillation	1.60	(0.54 – 4.76)	0.396	2.07	(0.83 – 5.19)	0.119
Cardiogenic shock (Killip IV)	6.59	(2.90 – 14.95)	< 0.001	4.42	(1.99 – 9.77)	< 0.001
STEMI	1.85	(0.71 – 4.80)	0.206	2.46	(0.89 – 6.71)	0.080
LVEF (%)	0.98	(0.95 – 1.01)	0.160	0.99	(0.96 – 1.02)	0.354
Renal dysfunction (eGFR< 60)	5.64	(1.59 – 20.04)	0.008	5.92	(1.79 – 19.53)	0.004
Revascularization (emergency PCI or CABG)	0.66	(0.28 – 1.58)	0.350	0.24	(0.10 – 0.56)	< 0.001

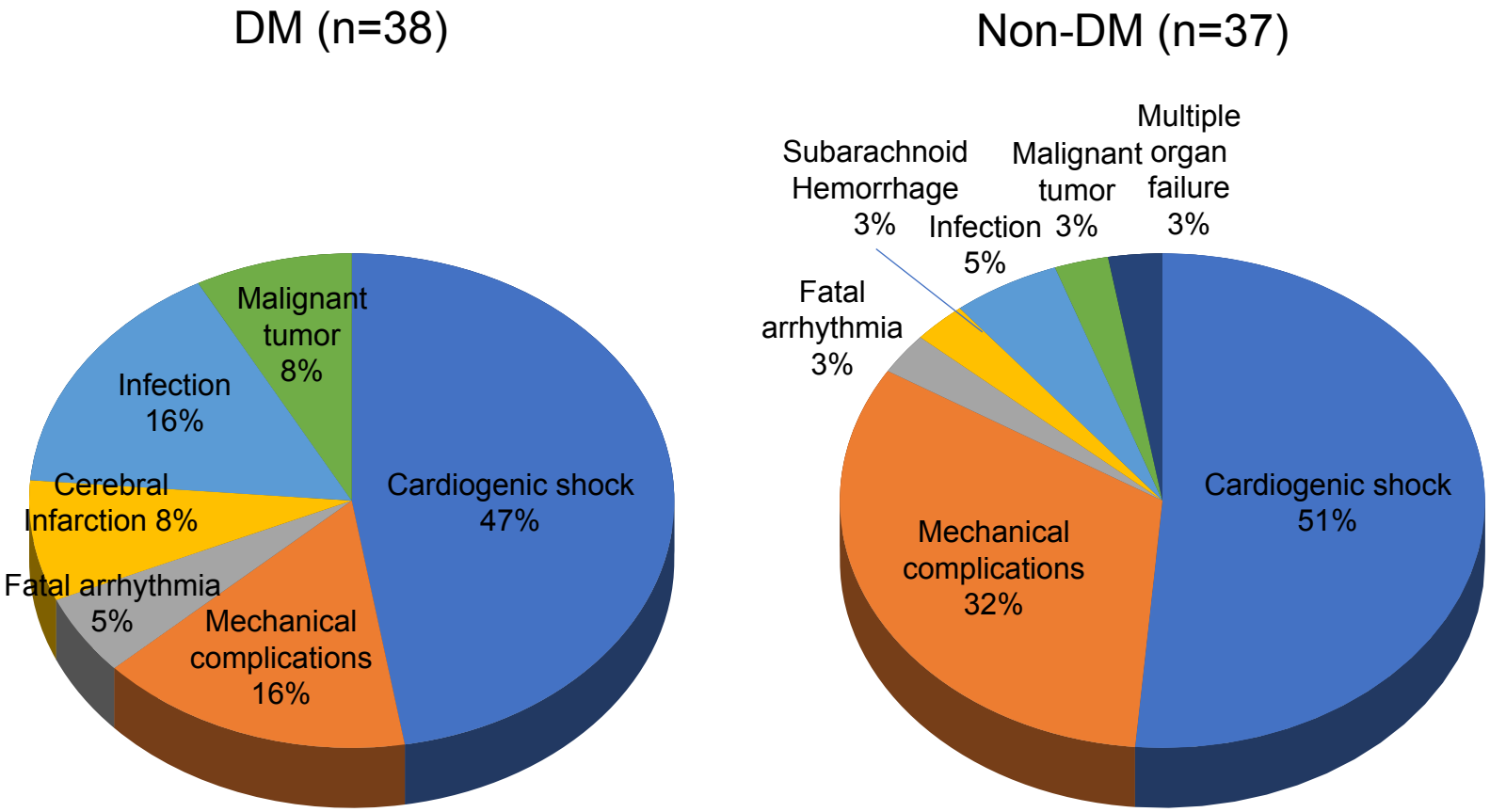
DM: diabetes mellitus, HR: hazard ratio, CI: confidence interval, STEMI: ST elevation myocardial infarction, LVEF: left ventricular ejection fraction, eGFR: estimated glomerular filtration rate
PCI: percutaneous coronary intervention, CABG: coronary artery bypass grafting

Figure 1.



Number at risk							
DM group	32	21	15	25	8	1	0
Non-DM group	32	14	8	4	3	1	0

Figure 2.


DM (n=38)
Malignant tumor 8%
Infection 16%
Cerebral Infarction 8%
Fatal arrhythmia 5%
Mechanical complications 16%
Cardiogenic shock 47%
Non-DM (n=37)
Subarachnoid Hemorrhage 3%
Malignant tumor 3%
Multiple organ failure 3%
Infection 5%
Fatal arrhythmia 3%
Mechanical complications 32%
Cardiogenic shock 51%