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Nationwide cohort study of outcomes of acute myocardial infarction in patients with liver cirrhosis

A nationwide cohort study

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Abstract

Liver cirrhotic predisposes patients to coagulopathy and bleeding. Little is known about outcomes of acute myocardial infarction (AMI) in cirrhotic patients.

Data from Taiwan National Health Insurance Research Database during 2001 to 2013 were retrieved for patients admitted with cirrhosis and AMI. We excluded patients with missing information, <20 years old, previous AMI, previous coronary intervention, and liver transplant. Patients were separated into cirrhotic and non-cirrhotic. Primary outcomes included all-cause mortality, recurrent myocardial infarction (MI), major cardiac and cerebrovascular events (MACCE: recurrent MI, revascularization, ischemic stroke, and heart failure), and liver outcomes (hepatic encephalopathy, ascites tapping, spontaneous peritonitis, and esophageal varices bleeding).

A total of 3217 cirrhotic patients and 6434 non-cirrhotic patients were analyzed, with a mean follow up of 2.8±3.3 years. In cirrhotic patients with AMI, subsequent coronary and cerebrovascular events were lower in comparison to non-cirrhotic patients, with higher all-cause mortality observed from adverse liver related outcomes and bleeding. There were significantly lower cumulative incidence of both recurrent MI and MACCE in cirrhotic patients with AMI compared with non-cirrhotic patients with AMI (hazard ratio [HR] 0.82, confidence interval [CI] 0.71–0.94, $P = .006$ and HR 0.86, 95% CI 0.79–0.92, $P < .001$, respectively). There was significantly higher cumulative incidence of liver related outcome in cirrhotic patients with AMI compared with non-cirrhotic patients with AMI (HR 2.27, 95% CI 2.06–2.51, $P < .001$). And there was significantly higher all-cause mortality in cirrhotic patients with AMI compared with non-cirrhotic patients with AMI (HR 1.30, 95% CI 1.23–1.38, $P < .001$).

In cirrhotic cohort with AMI, a decreased in coronary and cerebrovascular events were observed. However, these patients also had higher all-cause mortality due to adverse liver outcomes and bleeding.

Abbreviations: AMI = acute myocardial infarction, CABG = coronary artery bypass grafting, EMR = electronic medical record, IABP = intra-aortic balloon pump, MACCE = major cardiac and cerebrovascular events, MI = myocardial infarction, NHI = National Health Institute, NHIRD = National Health Institute Research Database, PCI = percutaneous coronary intervention, VF = ventricular fibrillation, VT = ventricular tachycardia.

Keywords: acute myocardial infarction, cirrhosis, outcome

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1. Introduction

The liver has dual roles in governing the physiological coagulation cascade. Patients with liver cirrhosis have impaired synthesis of coagulation factors and reduced platelet function that can secondarily affect hemostasis, anticoagulation, and fibrinolysis. It is commonly observed that patients with cirrhosis have prolonged coagulation time and some considered these patients as "naturally-anticoagulated." However, the decreased levels of procoagulants accompany the diminished levels of natural anticoagulants, and therefore patients with cirrhosis are also at risk for thrombotic complications, including portal vein thrombosis and venous thromboembolism.[1,2] In addition, the altered hemostasis, coagulation, and fibrinolysis in cirrhotic patients resulted in "shifted hemostasis" which also leads to increased bleeding.[3] The use of anticoagulants is thus controversial in patients with liver cirrhosis for whom ischemic heart disease is encountered.[4]

Patients with acute myocardial infarction (AMI) have high mortality and require timely coronary intervention and meticulous medical treatment. Although medical therapy for AMI has been advancing at fast pace in recent years, in patients with liver cirrhosis with concomitant AMI, the management can be complex. In a recent nationwide study in the United States, ST elevation myocardial infarction mortality in patients with cirrhosis is higher compared with patients without cirrhosis.[5] However, this mortality difference declined from 1999 to 2009, likely because of higher coronary artery stent utilization for patients with cirrhosis.[5] In the studies of medication use in cirrhotic patients with AMI in Asia, mortality were related to liver complications in cirrhotic patients, and the combined cardiac and liver complications in cirrhotic patients with AMI.[6,7] Therefore in this study, we aimed to investigate the clinical outcome of AMI in patients with liver cirrhosis in Asia.

2. Methods

2.1. Data source

Taiwan's National Health Institute (NHI) Program started in 1995 and provides 99.5% coverage for the 23 million residents in Taiwan. The NHI Research Database (NHIRD) provides all dates of inpatient and outpatient services, diagnosis, prescriptions, examinations, operations, and expenditures, and data are updated biannually. With over 95% of Taiwan's population consists of Han Chinese, our study is considered to be uniform in ethnic background. The NHI system offers detailed follow-up information on medication, intervention, admission, outpatient clinic, and emergency visit of patients. In addition, accurate records of health reimbursement are ensured by prescription of medications and arrangement of interventions being followed by appropriate examinations and indications. On the other hand, false reimbursement claims can result in magnified penalty. The Institutional Review Board of Chang Gung Memorial Hospital Linkou Branch approved this study (IRB No. 201800177B1).

2.2. Study patients

By searching electronic medical records from the NHIRD between January 1, 2001 and December 31, 2013, we retrieved patients with a principal diagnosis of AMI admission. The date of discharge from the index admission was defined as the index date. We excluded patients who had missing information, patients <20 years old, had previous AMI, had previous coronary intervention, and had liver transplant. We further separated patients into cirrhotic patients and non-cirrhotic patients, using the diagnosis of cirrhosis being 2 consecutive outpatient diagnoses or 1 inpatient diagnosis before the index date. Both the diagnoses of AMI and liver cirrhosis in NHIRD have been validated against hospital electronic medical records in previous studies.[8,9]

2.3. Covariate and study outcomes

Diseases were detected using International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes. Covariates included age, sex, clinical medical history of hypertension, diabetes mellitus, hyperlipidemia, heart failure, peripheral arterial disease, atrial fibrillation, history of stroke, chronic kidney disease, end-stage renal disease, and malignancy at baseline. The comorbidity was defined as having 2 outpatient diagnoses or 1 inpatient diagnosis in the previous year. Most diagnostic codes of these comorbidities have been validated in previous NHIRD studies.[8,10,11] Liver cirrhosis or AMI related complications were also defined according to the diagnosis of ICD-9-CM (Supplement Table 1, http://links.lww.com/MD/D963).

In-hospital outcomes were analyzed and detected by ICD-9-CM code or Taiwan NHI order code. Outcomes of primary interest included all-cause mortality, recurrent myocardial infarction (MI), major cardiac and cerebrovascular events (MACCE, including recurrent myocardial infarction, revascularization such as percutaneous coronary intervention [PCI] and coronary artery bypass grafting [CABG], ischemic stroke and heart failure, and cardiovascular death), and liver outcomes (any liver outcome, hepatic encephalopathy, ascites tapping, spontaneous peritonitis, esophageal varices bleeding, and hypoalbuminemia), major bleeding. All-cause mortality was defined by withdrawal from the national health insurance.[12] The diagnostic codes of heart failure and stroke have also been validated.[11,13,14] The liver-related outcomes were also reported in our previous work.[15] Each patient was followed until the day of outcome occurrence, death or December 31, 2013, whichever came first.

2.4. Statistical analysis

To reduce bias due to confounding, we performed a propensity score matching (PSM) with a 1:2 ratio which each patient in the cirrhosis group was matched with 2 counterparts in the non-cirrhosis group.[16] The covariates to calculate propensity score (the predicted probability to be cirrhosis group derived from logistic regression) included demographics (age and sex), monthly income, urbanization level, 10 comorbidities, hospital level, coronary intervention at the index admission, stent type in patients who received stent and the index date (listed in Table 1). The matching was processed using a greedy nearest neighbor algorithm with a caliper of 0.2.[17] The quality of matching was checked using the absolute standardized mean difference (ASMD) between the groups after matching which a value <0.1 was considered to have negligible difference between groups.[18]

As to in-hospital outcome, we compared the risk of binary outcome (i.e., in-hospital mortality) and continuous outcome (i.e., ICU duration days) by using generalized estimating equation (GEE) in which the correlation among patients within the same

Table 1

Clinical characteristics of study population before and after propensity score matching.

Variable	Before matching			After matching		
	Cirrhosis (n = 3217)	Non-cirrhosis (n = 129,393)	ASMD	Cirrhosis (n = 3217)	Non-cirrhosis (n = 6434)	ASMD
Characteristics						
Age, y	68.6 ± 13.2	66.2 ± 14.2	0.180	68.6 ± 13.2	69.0 ± 14.0	0.028
Age ≥65	2000 (62.2)	70,701 (54.6)	0.153	2000 (62.2)	4038 (62.8)	0.012
Male gender	2287 (71.1)	92,559 (71.5)	0.010	2287 (71.1)	4558 (70.8)	0.005
Monthly income, NT$						
Low (0–17,880)	1304 (40.5)	49,433 (38.2)	0.048	1304 (40.5)	2638 (41.0)	0.009
Medium (17,881–22,800)	1225 (38.1)	42,247 (32.7)	0.114	1225 (38.1)	2468 (38.4)	0.006
High (>22,800)	688 (21.4)	37,713 (29.1)	0.179	688 (21.4)	1328 (20.6)	0.018
Urbanization level						
Rural	588 (18.3)	17,242 (13.3)	0.136	588 (18.3)	1191 (18.5)	0.006
Town	1063 (33.0)	38,676 (29.9)	0.068	1063 (33.0)	2128 (33.1)	0.001
Urban	899 (27.9)	39,791 (30.8)	0.062	899 (27.9)	1781 (27.7)	0.006
Metropolis	667 (20.7)	33,684 (26.0)	0.125	667 (20.7)	1334 (20.7)	0.000
Comorbidity						
Hypertension	2163 (67.2)	82,151 (63.5)	0.079	2163 (67.2)	4321 (67.2)	0.002
Diabetes mellitus	1522 (47.3)	49,329 (38.1)	0.187	1522 (47.3)	3068 (47.7)	0.007
Hyperlipidemia	747 (23.2)	47,718 (36.9)	0.301	747 (23.2)	1407 (21.9)	0.032
Heart failure	574 (17.8)	10,475 (8.1)	0.293	574 (17.8)	1144 (17.8)	0.002
Peripheral arterial disease	157 (4.9)	4789 (3.7)	0.058	157 (4.9)	282 (4.4)	0.024
Atrial fibrillation	331 (10.3)	8885 (6.9)	0.122	331 (10.3)	678 (10.5)	0.008
Old stroke	723 (22.5)	19,275 (14.9)	0.195	723 (22.5)	1536 (23.9)	0.033
Chronic kidney disease	1063 (33.0)	25,984 (20.1)	0.297	1063 (33.0)	2132 (33.1)	0.002
ESRD (dialysis)	270 (8.4)	4297 (3.3)	0.217	270 (8.4)	500 (7.8)	0.023
Malignancy	449 (14.0)	5480 (4.2)	0.343	449 (14.0)	835 (13.0)	0.029
Hospital level						
Medical center (teaching hospital)	1181 (36.7)	57,161 (44.2)	0.153	1181 (36.7)	2363 (36.7)	0.000
Regional/district hospital	2036 (63.3)	72,232 (55.8)	0.153	2036 (63.3)	4071 (63.3)	0.000
Coronary intervention at the index admission	1290 (40.1)	74,373 (57.5)	0.353	1290 (40.1)	2529 (39.3)	0.016
PCI	1206 (37.5)	70,050 (54.1)	0.339	1206 (37.5)	2362 (36.7)	0.016
CABG	96 (3.0)	5162 (4.0)	0.055	96 (3.0)	191 (3.0)	0.001
Patients who received stent	890 (27.7)	49,818 (38.5)	0.232	890 (27.7)	1735 (27.0)	0.016
BMS	708 (22.0)	38,229 (29.5)	0.173	708 (22.0)	1394 (21.7)	0.008
DES	199 (6.2)	12,862 (9.9)	0.138	199 (6.2)	384 (6.0)	0.009

ACEI = angiotensin-converting enzyme inhibitors, ARB = angiotensin receptor blockers, ASMD = absolute standardized mean difference, BMS = bare-metal stent, CABG = coronary artery bypass grafting, DCCB = dihydropyridine calcium channel blockers, DES = drug-eluting stent, ESRD = end stage renal disease, NDCCB = non-dihydropyridine calcium channel blockers, PCI = percutaneous coronary intervention.

matching pair was considered.[19] We compared the risk of all-cause mortality between groups using a Cox proportional hazard model. The risk of other time to event outcomes between groups was compared using a subdistribution hazard model which considered death during the follow up as a competing risk.[20] Matching pairs were stratified in both Cox and subdistribution hazard models. We generated the plot of cumulative incidence rate using subdistribution cumulative incidence function for time to event outcomes except all-cause mortality (i.e., major composite liver outcome). Unadjusted cumulative event rate of all-cause mortality was calculated and plotted. The study group (cirrhosis vs non-cirrhosis) was the only explanatory variable in GEE, Cox, and subdistribution hazard models. A P value $<.05$ was considered to be statistically significant and no adjustment of multiple testing (multiplicity) was made in this study. All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC), including procedure of "psmatch" for propensity score matching, "genmod" for generalized estimating equation, "phreg" for survival analysis, and the macro of "%*cif*" for cumulative incidence function.

3. Results

3.1. Study population

A total of 150,887 patients admitted to hospital with a principal diagnosis of AMI during 2001 and 2013 were identified in the NHIRD. After exclusion criteria, a total of 132,610 patients with AMI were eligible for analysis. Among these, 3217 had history of cirrhosis and 129,393 had no history of cirrhosis. Using 1:2 propensity score matching, there were 3217 patients in the liver cirrhosis group and 6434 patients in non-cirrhosis group analyzed (Fig. 1), with a mean follow up of 2.8 ± 3.3 years. Baseline clinical characteristics of study patients before and after matching were given in Table 1. After matching, there were no significant differences between cirrhosis group and non-cirrhosis group in all clinical characteristics of age, sex, income level, urbanization level, comorbidity, hospital level, coronary intervention at index admission, and patients who received stent. In patients with cirrhosis, baseline clinical variable are shown in Table 2, using previously defined terms on complication of cirrhosis.[8]

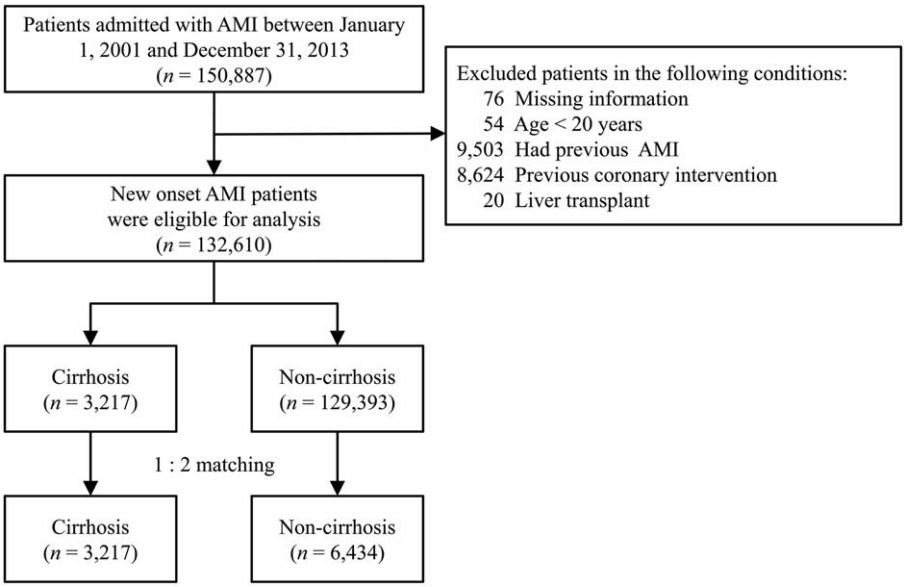

Figure 1. Flow chart and study design for the inclusion the study patients.

3.2. Epidemiology of AMI in cirrhosis

During 2001 to 2013, there was an increasing number of patients with AMI (P trend <.001). During the same period of time, there were also slightly increased cirrhotic patients with AMI (P trend = .004). For both cirrhotic patients with AMI and non-cirrhotic patients with AMI, in-hospital mortality decreased during this period of time (P trend <.001 and P trend <.001, respectively) (Fig. 2).

3.3. In-hospital outcome

There were significantly lower number of ventricular tachycardia (VT)/ventricular fibrillation (VF) and the use of intra-aortic balloon pump in cirrhotic patients with AMI compared with non-cirrhotic patients with AMI. On the other hand, there was significantly higher number of patients with GI bleeding requiring intravenous proton pump inhibitor in cirrhotic patients with AMI compared with non-cirrhotic patients with AMI (Table 3).

Table 2

Liver cirrhosis related clinical characteristics of the patients.

Variable	Cirrhosis (n = 3217)
Alcoholic cirrhosis	706 (21.9)
Virus hepatitis, HBV	611 (19.0)
Virus hepatitis, HCV	645 (20.0)
Old GI bleeding	1491 (46.3)
Old major bleeding	579 (18.0)
Complication of cirrhosis	
Hepatic encephalopathy	242 (7.5)
Ascites and related complication	483 (15.0)
Esophageal varices bleeding	194 (6.0)
Coagulopathy	110 (3.4)
Admission for albumin infusion (hypoalbuminemia)	413 (12.8)
Catastrophic illness certificate	
No	3070 (95.4)
Yes	147 (4.6)
Modified Child-Pugh score classification	
0	2265 (70.4)
1	625 (19.4)
≥2	327 (10.2)

GI = gastrointestinal, HBV = hepatitis B virus, HCV = hepatitis C virus.

3.4. One-year clinical outcome

In cirrhotic patients with AMI, subsequent coronary and cerebrovascular events were lower in comparison to non-cirrhotic patients, with higher all-cause mortality observed from adverse liver related outcomes and bleeding (Fig. 3A). In terms of cardiovascular events, there were significantly lower cumulative incidence of both recurrent MI and MACCE in cirrhotic patients with AMI compared with non-cirrhotic patients with AMI (hazard ratio [HR] = 0.82, confidence interval [CI] = 0.71–0.94, P = .006 and HR = 0.86, 95% CI = 0.79–0.92, P < .001, respectively) (Fig. 3B and C). However, there was significantly higher cumulative incidence of liver related outcome in cirrhotic patients with AMI compared with non-cirrhotic patients with AMI (HR = 2.27, 95% CI = 2.06–2.51, P < .001) (Fig. 3D). Therefore, there was significantly higher all-cause mortality in cirrhotic patients with AMI compared with non-cirrhotic patients with AMI (HR = 1.30, 95% CI = 1.23–1.38, P < .001).

4. Discussion

Our study has the following major findings. The mortality rate of cirrhotic patients with AMI is improving and is comparable non-cirrhotic patients with AMI between 2001 and 2013. This is the first and largest study to directly compare the clinical outcome of cirrhotic versus non-cirrhotic patients with AMI using propensity score matching. Compared with non-cirrhotic patients with AMI, cirrhotic patients with AMI had lower rates of VT/VF and intra-aortic balloon pump (IABP) use during in-hospital course, and lower rates of recurrent MI and MACCE during 1-year follow up.

In patients with liver cirrhosis, the frequently encountered clinical scenarios are bleeding and thrombosis. The "shifted balance" of coagulation system in cirrhotic patients however,

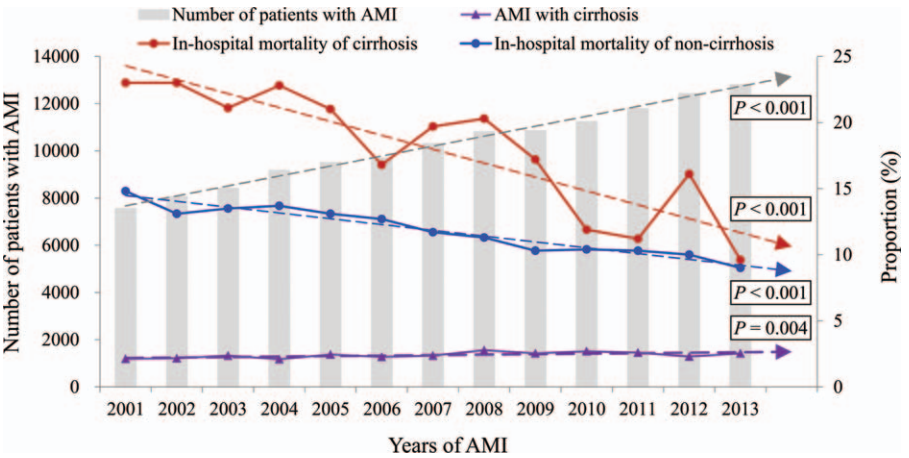

Figure 2. Incidence of patients with AMI, cirrhotic patients with AMI, in-hospital mortality rate of cirrhotic patients with AMI, and in-hospital mortality rate of non-cirrhotic patients with AMI. AMI = acute myocardial infarction.

could not provide us with a definitive direction how this altered hemostasis would behave during the event of AMI. Early autopsy reports have noted lower prevalence of MI in cirrhotic patients compared with the general population.[21,22] In clinical studies, the prevalence of MI was also significantly lower in cirrhotic patients compared with non-cirrhotic patients (1.7% vs 6.4%).[23] In a recent study using registry-based matched case–control study, prevalence of subclinical but obstructive coronary artery disease was neither higher nor lower in cirrhotic patients although the prevalence of the more benign non-obstructive coronary artery disease was higher.[24] Therefore in cirrhotic patients with AMI, we are concerned if the coagulopathy secondary to cirrhosis would modify the clinical course of atherosclerotic and atherothrombotic complications during and post-AMI, which are recurrent MI, and a composite of recurrent MI, revascularization (PCI/CABG), ischemic stroke, and heart failure that may be summarized as MACCE.

In previous study of ST elevation myocardial infarction (STEMI) in acute care hospitals across United States, STEMI mortality in patients with cirrhosis was higher compared with patients without cirrhosis.[5] The age-adjusted mortality rates were 31% for cirrhotic and 11% for non-cirrhotic patients with AMI in 1999 that improved over years to 17% for cirrhotic and 9% with non-cirrhotic patients with AMI in 2009.[5] The adjusted mortality odds ratio 2.54 in 1999 and 1.45 in 2009 probably related to higher coronary artery stent utilization for patients with cirrhosis.[5] In our study, the propensity score matched subjects had mortality rates of 17.2% in cirrhotic and 16.6% rates in non-cirrhotic patients with AMI over entire study period 2001 to 2013. This may be related to our study population being elder with mean age 68.6 ± 13.2 in the cirrhotic and 69.0 ± 14.0 in the non-cirrhotic patients with AMI, compared with the US study population with median age 66.7 in cirrhotic and 67.1 in non-cirrhotic patients with AMI in 1999, and 62.3 in cirrhotic and 62.0 in non-cirrhotic patients with AMI in 2009.[5]

In this study, the 13-year annual rate of AMI has been increasing at a steady pace from 2001 to 2013. During the same period of time, number of cirrhotic patients with AMI seemed

Table 3

In-hospital outcome.

Variable	Cirrhosis (n = 3217)	Non-cirrhosis (n = 6434)	Cirrhosis versus non-cirrhosis	
			OR/*B* (95% CI)	*P* value
Categorical outcome				
In-hospital mortality	552 (17.2)	1065 (16.6)	1.04 (0.93, 1.17)	.450
de novo dialysis	137 (4.3)	292 (4.5)	0.94 (0.76, 1.15)	.530
VT/VF	273 (8.5)	681 (10.6)	0.78 (0.68, 0.91)	.001
IABP	184 (5.7)	457 (7.1)	0.79 (0.67, 0.95)	.010
ECMO	22 (0.7)	47 (0.7)	0.94 (0.56, 1.56)	.798
Shock	985 (30.6)	1924 (29.9)	1.04 (0.94, 1.13)	.470
GI bleeding	337 (10.5)	462 (7.2)	1.51 (1.31, 1.75)	<.001
PPI IV form	532 (16.5)	647 (10.1)	1.77 (1.57, 2.01)	<.001
Atrial fibrillation	203 (6.3)	433 (6.7)	0.93 (0.79, 1.11)	.434
Continuous outcome				
ICU duration, d	4.2 ± 7.3	4.3 ± 6.8	−0.06 (−0.36, 0.24)	.694
Hospital stays, d	9.9 ± 12.7	9.5 ± 12.3	0.35 (−0.18, 0.88)	.195
In-hospital cost (NTD × 10^4)	14.7 ± 18.8	14.4 ± 17.3	0.26 (−0.50, 1.01)	.501

B = regression coefficient, CI = confidence interval, ECMO = extracorporeal membrane oxygenation, IABP = intra-aortic balloon pump, ICU = intensive care unit, IV = intravenous, NTD = new Taiwan dollars, OR = odds ratio, PPI = proton pump inhibitor, VT/VF = ventricular tachycardia/ventricular fibrillation.

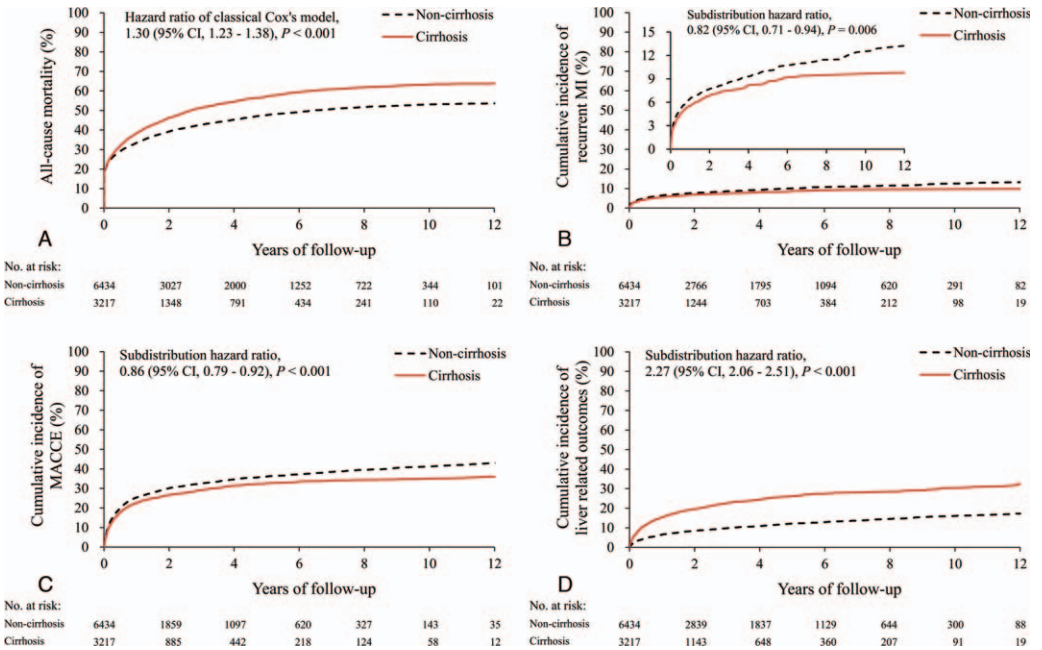

Figure 3. The unadjusted event rate of all-cause mortality (A), and cumulative incidence function of recurrent myocardial infarction (B), MACCE (C), and liver related outcome (D) in cirrhotic patients with AMI and non-cirrhotic patients with AMI. AMI = acute myocardial infarction, MACCE = major adverse cardiac and cerebrovascular events.

only very slightly increased, translating into that liver cirrhosis may have certain inherent protection against ischemic heart disease. With improved medical treatment options and coronary intervention strategies, cirrhotic patients with AMI have improved in-hospital mortality over time and is comparable to non-cirrhotic patients with AMI. A closer look at in-hospital events showed a significantly lower rates of VT/VF and IABP use in cirrhotic patients with AMI compared with non-cirrhotic patients with AMI, reflecting possibly decreased severity of coronary artery obstruction in these patients. Understandably, the "shifted hemostasis" as mentioned earlier,[3] also predisposed cirrhotic patients with AMI with significantly higher rate of GI bleeding leading to intravenous use of proton pump inhibitor, compared with non-cirrhotic patients with AMI.

During the 1-year follow up, our results showed higher rates of all-cause mortality in cirrhotic patients compared with non-cirrhotic patients with AMI, possibly relating to the concurrent cirrhotic complications of hepatic encephalopathy, ascites, esophageal varices, coagulopathy, and hypoalbuminemia. However, in terms of cardiovascular events of recurrent MI and MACCE that included stroke, cirrhotic patients with AMI were associated with lower events compared with non-cirrhotic patients.

Although previously it was debated exactly how cirrhotic patients are protected against ischemic events, our study suggested that naturally-anticoagulated system may affect the atherosclerosis in the coronary and cerebrovascular arteries. As seen in this cohort in Table 1, cirrhotic patients with AMI had significantly less percentage of patients requiring coronary intervention (both percutaneous coronary intervention and coronary artery bypass grafting), and stent deployment (both bare-metal stent and drug-eluting stent) before propensity score matching. Therefore it is possible that cirrhotic patients had lower levels of coronary plaque burden. On the other hand, cirrhotic patients with AMI had significantly higher event rates in terms of liver related outcomes including but not limited to hepatic encephalopathy, ascites tapping, spontaneous peritonitis, esophageal varices bleeding, compared with non-cirrhotic patients without AMI.

In summary, this is the first and largest study to directly compare clinical outcome of cirrhotic patients with AMI and non-cirrhotic patients with AMI. Our results suggested that cirrhotic patients were associated with decreased coronary and cerebrovascular events.

5. Limitations

There are several limitations in epidemiologic data from NHIRD. First, due to the limitation of claim-based NHIRD where clinical evaluation and laboratory data were unavailable for the patients, the traditional risk stratification using Child-Pugh criteria in patients with liver cirrhosis could not be performed. However, we used modified Child-Pugh score classification to stratify the degree and severity of liver cirrhosis as previously published.[8] Second, using ICD-9-CM codes for patient screening may miss some cases for conditions not coded correctly. However, ICD-9-CM codes against hospital electronic medical records (EMR) have been performed in the validation studies for NHIRD, the ICD codes have as sensitivity up to 99% for positive predictive value against the gold standard EMR.[8] Third, the all-cause mortality was defined by withdrawal from the NHI, and the cause of death was defined as the discharge diagnosis within the last 3 months of NHI withdrawal. Therefore in certain patients the cause of deaths could only be approximated but not exact. Last, since our study consisted of homogeneous ethnic background, application of the results to other populations requires interpretation in the proper context.

6. Conclusions

In cirrhotic patients with AMI, there were associated decreased coronary and cerebrovascular events. However, these patients also had higher all-cause mortality due to adverse liver outcomes and major bleeding. Further management with liver cirrhosis related complications should improve overall outcome in these patients.

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